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BY

G. E. GATES

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ON SOME SPECIES OF CHINESE EARTHWORMS, WITH SPECIAL REFERENCE TO SPECIMENS COLLECTED IN SZECHWAN BY DR. D. C. GRAHAM

By G. E. Gates

Since 1921 Dr. David C. Graham, of the West China Mission of the American Baptist Foreign Mission Society, has been collecting much natural-history material in the vicinity of his station at Suifu, Province of Szechwan, western China, as well as in the course of his travels through that Province. At the request of Dr. Waldo L. Schmitt, of the United States National Museum, I undertook the study of Dr. Graham's earthworms and began work in 1926. At that time little was known of the earthworms of China and nothing at all of the oligochaete fauna of the interior Province of Szechwan. Most of the known Chinese species had been characterized so inadequately that it was considered advisable to postpone publication until the types could be examined. Early in 1931, while I was on furlough from my duties at Judson College, Rangoon, the opportunity first came for me to study material in European museums, but currency fluctuations following American abandonment of the gold standard necessitated my abrupt departure from Europe before the work was completed. Before leaving, however, I studied the types or representative portions of type series of all species discussed herein except *Drawida japonica* (Michaelsen), *Pheretima hupeiensis* (Michaelsen), and *P. asiatica* (Michaelsen).

The original manuscript of this paper was completed in 1934, but as it was then impossible to publish it in full a preliminary report

on the new species was published (Gates, 1935). The paper is now brought to date to the end of 1936.

I wish to express my heartiest thanks to Dr. Waldo L. Schmitt for assistance on so many occasions as well as for the opportunity of examining Dr. Graham's material; to Dr. Max Thiel and Dr. Wilhelm Michaelsen, of the Hamburg Museum, and Dr. C. C. A. Monro, of the British Museum, for the courtesies of their institutions and for personal assistance given many times; to the Metropolitan Museum of China for forwarding specimens for examination; to Y. Chen for the opportunity of examining some of his specimens; and to the authorities of the Biological Institute of Harvard University and the Marine Biological Laboratory at Woods Hole, Mass., for accommodations provided while I was engaged in the final preparation of the manuscript.

Family MONILIGASTRIDAE

Genus DESMOGASTER Rosa

DESMOGASTER SINENSIS Gates

1930. *Desmogaster sinensis* GATES, Ann. Mag. Nat. Hist., ser. 10, vol. 6, p. 590 (type locality: Soochow; type in author's collection).

1933. *Desmogaster sinensis* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 9, p. 180.

Material examined.—From the U. S. National Museum: 3 aclitellate specimens labeled "*Desmogaster sinensis* Gates; Soochow, China; identified by Y. Chen."

Remarks.—These specimens are much smaller than the type. No setae are visible on any of the worms. The spermathecal tubercles are more like anteroposteriorly flattened flaps than on the type.

The largest specimen was opened. The gizzards are three, in xiv–xvi. The nephridium of one side of xiii passes at its dorsal end into the ovisac, which otherwise is empty.

Genus DRAWIDA Michaelsen

DRAWIDA GISTI Michaelsen

1931. *Drawida gisti* MICHAELSEN, Peking Nat. Hist. Bull., vol. 5, pt. 3, pp. 1, 8 (type locality: Tsinan, Shantung; types in Hamburg and Peiping Museums); Zool. Jahrb. (Abt. Syst.), vol. 61, p. 525.

1935. *Drawida gisti* GATES, Smithsonian Misc. Coll., vol. 93, no. 3, p. 2.

Material examined.—From the Hamburg Museum: 2 clitellate specimens labeled "*D. gisti.*"

External characteristics.—The setae begin on ii and are closely paired; *aa* slightly less than *bc*.

The nephridiopores of viii–xiii may or may not be displaced rather markedly dorsal to *d*.

The clitellar coloration (pinkish) extends across segments x–xiv and onto the posterior portion of ix.

The spermathecal pores are transverse slits on 7/8 just median to *c*, the anterior margin of the pore swollen so that the pore appears to be slightly behind 7/8. The female pores are minute, dark, grayish spots in slight, transverse, slitlike depressions on the anterior margin of xii, the slits in *ab*.

The apertures of the penial chambers are on 10/11 in *bc*, slightly nearer to *b* than to *c*. The true male pore is much smaller and at the ventral end of a penis, which may be completely withdrawn into the penial chamber (invisible from the exterior) or slightly protuberant through the chamber aperture.

On one specimen there is a pair of small presetal genital markings on x. Each of these markings is circular in outline, slightly elevated, about equal in width to interval *ab*, the median margin of the marking about in line *b*. The margin of the marking is opaque, the center of the marking of a grayish translucence. The clitellar coloration is lacking on a ventral region that includes the genital markings and extends across the anterior portion of x and the posterior portion of ix. On the second specimen a rather vague protuberance somewhat resembling the genital markings just described can be seen anteriorly on viii, in *ab*. The whitened ventral region is lacking on this worm.

Internal anatomy.—The gizzards are three, in xii–xiv (2 specimens). There are paired enterosegmental organs in several successive segments, beginning from xvi. There is a band of opaque whitish material on each side of the dorsal blood vessel. The last pair of hearts is in ix.

The testis sacs are kidney-shaped, the concave side directed ventrally; in ix and x, unconstricted by 9/10. The vas deferens is rather short and is twisted into two bunches of loops, the smaller on the anterior face of 9/10, the larger on the posterior face, the total mass of the two bunches of loops very much less than that of the testis sac above. The prostates are 6–7 mm in length. The middle portion is bent into a sort of C-shape and is placed around the penial chamber so that the open side of the C faces mesially. An ental portion is almost straight and pushes through 9/10 (at least in one specimen) into ix. An ectal portion of the prostate is bent under the posterior limb of the C and appears to pass into the lateral face of the penial chamber, close to the parietes. The granulations (external glandular layer) on the prostate extend to this apparent point of entrance into the penial chamber. Removal of a layer of connective tissue from the coelomic face of the chamber reveals a very slender, smooth, and glistening prostatic duct, which passes upward and into the chamber

about at the center of the dorsal face. Granulations (external glandular layer) are lacking on this duct portion, which is about one-half as long as the gland, the prostate and duct together being 9–11 mm long. The granulations can be scraped off from the prostate revealing a firm, rather slenderly tubular, glistening, central body, which decreases very gradually and only very slightly in width passing ectally. The penial chamber projects conspicuously into the coelomic cavity to a height of 1½–2 mm, the dorsal surface smooth and regularly convex. The diameter is less than the height. The penis is 1–1½ mm long, slightly widened at the base (dorsally).

Laterally and dorsally septa 10/11 and 11/12 are attached to the parietes close together. In spite of the fact that both specimens were opened with considerable care, segment xi was opened by the dorsal incision in each worm. An ovarian chamber of the horseshoe type is apparently lacking in this species. The ovarian segment is filled with loose ova (2 specimens). The ovisacs are not fully distended by ova and extend only into xiii and xiv or into xiv and xv.

The spermathecal ampulla is collapsed and contains only a small quantity of whitish material. The duct is twisted into a number of loops immediately under the ampulla and thence ectally is gradually widened. The duct passes, without definite external demarcation, into a rather digitiform atrium, which is in viii. In the wall of each spermathecal atrium (4 spermathecae) is a single, "urn-shaped" gland. The gland is almost spheroidal, pinkish, hard, rather large, the diameter of the gland greater than the thickness of the atrium.

Dorsal to each of the two genital markings of the first specimen is a parietal gland that projects into the coelomic cavity. No gland was found in the parietes of viii of the second specimen.

Remarks.—Drawida gisti is close to *D. hehoensis* Stephenson, 1924 (from Burma), from which it is distinguished as follows: Restriction of gizzards to segments xii–xiv; binding of a stalk portion of the prostate to the lateral face of the penial chamber by connective tissue; greater length of the penis; larger size of the spermathecal atria; incomplete closure of the ovarian segment; presence of an "urn-shaped" gland in the wall of each spermathecal atrium; presence of definite genital markings and their associated glands.

DRAWIDA GRAHAMI Gates

1935. *Drawida grahami* GATES, Smithsonian Misc. Coll., vol. 93, no. 3, p. 3 (type locality: Suifu, Szechwan; types in U. S. National Museum).

1936. *Drawida grahami* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 11, p. 291 (after examination of types).

Material examined.—From Dr. Graham: 6 aclitellate or partially clitellate specimens and 1 clitellate specimen labeled "Suifu, Sept. 1924."

External characteristics.—Length, about 55 mm. Diameter, 4 mm.

The setae begin on ii and are closely paired; *aa* about equal to or slightly greater than *bc*.

The clitellar coloration (reddish) extends over segments x–xiii and onto the posterior portion of ix.

The spermathecal pores are tiny transverse slits or rounded pits on 7/8, halfway between *b* and *c*. The female pores were not identified.

The male pores, small apertures in *bc*, nearer to *b* than to *c*, are on slightly protuberant porophores, which are not, on some specimens, clearly delimited. In those specimens on which the preservation of these structures is the best, the male pore is at the ventral tip of the protuberance and in line with intersegmental furrow 10/11, the latter ending blindly on the lateral and median sides of the porophore. The anterior margin of the porophore may be indicated by a slight transverse groove, which does not pass into the intersegmental furrow. The posterior margin of the porophore is marked off by a short transverse furrow that passes laterally and mesially into 10/11.

The genital markings are transversely oval to circular, convex areas of grayish translucence; the margin sharply delimited by a slight circumferential furrow. The epidermis immediately around each marking may be specially whitened, but a definite rim such as characterizes the markings of *D. japonica* seems to be lacking. The markings are located on segments vii–xiii as follows:

1. Segment viii—middle annulus, both sides, in *bc;* ix—middle annulus, both sides, in *bc;* x—middle annulus, left side, in *bc;* xi—middle annulus, both sides, in *bc*.

2. Segment ix—presetal, both sides. about in line with the spermathecal pores; xi—middle annulus, both sides, in *bc*; xii—presetal pair in *aa*; xiii—presetal pair in *aa*.

3. Segment vii—presetal, both sides, in *bc* and a postsetal median; x—posterior annulus, both sides, in *bc;* viii—middle annulus, both sides, in *ab;* ix—posterior annulus, both sides, in *bc;* xi—middle annulus, both sides, in *bc;* xiii—presetal, median pair.

4. Segment viii—presetal, left side, in *bc;* ix—presetal, both sides in *bc;* xii—middle annulus, both sides, in *bc;* xiii—presetal, median pair.

5. Segment vii—anterior annulus, both sides, in *ab* and a posterior median; viii—anterior annulus, left side, in *bc;* ix—presetal and median; x—postsetal and median; xi—middle annulus, left side, in *bc* and one presetal median; xiii—one presetal median.

6. Segment vii—postsetal, left side, in *be*, and one slightly to the right of the midventral line; viii—presetal, right side, in *bc;* ix—presetal, left side, in *bc;*

x—postsetal, both sides, in *ab;* xi—presetal pair in *aa;* xii—presetal, just to left of midventral line; xiii—presetal, both sides, in *aa.*

7. No genital markings.

Internal anatomy.—Septa 5/6-8/9 are thickly muscular; 9/10 thin and displaced posteriorly.

The last pair of hearts is in ix. There is a band of opaque material on each side of the dorsal blood vessel.

The gizzards are three in xii–xiv (8 specimens).

The testis sacs are usually flattened laterally and nearly fill the available space in segments ix and x. The vas deferens is short, rather thick relative to the size of the worm, and passes into the prostate mesially without first passing into the parietes. The prostates are flattened disks of circular outline, sessile on the parietes. The central body is tiny, ovoidal, the more pointed end within the parietes.

Segment xi is reduced to a closed-off ovarian chamber of horseshoe shape. The ovisacs are laterally flattened and confined to xii in the clitellate specimen. In other worms the ovisacs are slenderer and also confined to xii. A posteriorly elongated appendix such as characterizes *D. japonica* is lacking.

The spermathecal atrium is finger-shaped, erect on the posterior face of 7/8. The spermathecal duct (7–9 mm long) passes into the atrium near the ental end of the latter but runs ventrally in the atrial wall for a short distance before opening into the atrial lumen.

Remarks.—*D. grahami* is distinguished from *D. japonica* (Michaelsen, 1892) as follows: Location of the spermathecal pores in mid *bc* rather than in or just median to *c;* direct entrance of the vas deferens into the prostate (rather than first passing into the parietes); prostates disk-shaped and sessile on the parietes (rather than erect or vertical and columnar to club-shaped); the very small, ovoidal, central body of the prostate with the pointed end buried in the parietes (rather than the elongate digitiform central body nearly 1 mm in length); absence of an elongate rodlike appendix on the ovisacs. One of the types is clitellate, hence fully mature, and presumably would have had ovisac appendages if these structures are normally present in this species. (In contrast, the rodlike appendices of the ovisacs are recognizable even in juvenile specimens of *japonica.*) The exact morphological location of the male pores was not determined, but the pores are in line with 10/11, though the latter is not recognizable across the male porophores. If the male pores are to be placed on 10/11 or the site of 10/11 this will be still another distinction from *japonica* in which the pores are quite definitely segmental, postsetal on x.

Chen (1936, p. 291) maintains that the types of *grahami* are identical with *japonica.* Chen's notes on *grahami* appear to be a confused composite of observations made on specimens of both *grahami* and

japonica (note that Chen gives the number of gizzards as two or three and compare with statements regarding number of gizzards in *grahami supra* and *japonica infra;* also compare Chen's comments on the ovisac appendages with the account given below). Chen failed to notice the characteristics of the prostates, which is indeed "unfortunate," as these organs are of first importance in systematic discrimination in the genus *Drawida.*

DRAWIDA JAPONICA (Michaelsen)

1892. *Moniligaster japonicus* MICHAELSEN, Archiv für Naturg., vol. 58, p. 232 (type locality: Japan).
1927. *Drawida japonica* f. *typica* MICHAELSEN, Boll. Lab. Zool. Portici, vol. 21, p. 85 (Yunnan-fu).
1931. *Drawida japonicus* MICHAELSEN, Lingnan Sci. Journ., vol. 8, p. 157 (part) (excluding f. *siemsseni*); Peking Nat. Hist. Bull., vol. 5, pt. 3, pp. 1, 7 (part) (excluding f. *siemsseni*); Zool. Jahrb. (Abt. Syst.), vol. 61, p. 523 (part) (excluding f. *siemsseni* and in the synonymy *D. willsi*).
1935. *Drawida japonica* GATES, Smithsonian Misc. Coll., vol. 93, no. 3, p. 3.

Material examined.—From the Hamburg Museum: 3 specimens labeled "V 1194. *Drawida japonicus* Mich. f. Typ. Dr. Chen F. Wu c. Dr. Michaelsen a. Nanking, China." From Dr. Graham: 2 clitellate specimens labeled "Suifu, Szechwan, 1929"; 2 clitellate specimens labeled "Near Yueh Shi, 6,000–8,000 feet, August 11, 1928"; 1 specimen with slight clitellar coloration labeled "Near Mupin, July 8, 1929"; 1 clitellate specimen labeled "Tatsienlu, 8,300 feet, July 16, 1930."

External characteristics.—The length varies from 39 to 65 mm, the maximum diameter from 1 to 2 mm.

The setae begin on segment ii and are closely paired; *aa* about equal to or slightly less than *bc.*

The clitellar coloration varies from pink to red and extends over segments x to xiii and onto the posterior portion of ix.

The spermathecal apertures are tiny circular pores or short transverse slits on 7/8, on or just median to *c.* The female apertures are minute, grayish spots, each pore at the bottom of a transversely slitlike depression on the anterior margin of xii close to 11/12, in *ab.*

The male pores are readily recognizable or scarcely visible and are located on segment x on the ventral faces of more or less protuberant porophores in *bc*, nearer to *b* than to *c.* Intersegmental furrow 10/11 passes behind the porophores and is slightly displaced posteriorly in a concave fashion just behind each porophore. The anterior margin of the porophore may be demarcated by a slight transverse furrow, which does not pass at either end into furrow 10/11, or the furrow may be lacking, the porophore represented only by a slight parietal protuberance on which the male pore is located. The median margin of the porophore is at *b* or very slightly lateral to *b.*

The genital markings have a circular or transversely oval outline and usually are slightly protuberant. Each marking usually comprises an opaque rim and a central, grayish-translucent, circular portion, but occasionally the rim appears to be lacking. The markings are located on segments vii–xiii on the new specimens as follows:

1. Segment viii—anterior annulus, left side, just lateral to the spermathecal pore; ix—posterior annulus, left side, in *bc* but nearer to *b* than to *c;* x—posterior annulus, right side, just lateral to lateral margin of the male porophore.
2. Segment vii—posterior annulus, right side, lateral to spermathecal pore; viii—anterior annulus, each side, just lateral to the spermathecal pore; ix—middle annulus, right side, in *bc.*
3. Segment viii—presetal, right side, in *bc* just behind the spermathecal pore; ix—presetal, right side, in *bc;* x—presetal, left side, in *bc;* xi—presetal, right side, in *bc.*
4. Segment viii—presetal, left side, in *bc* slightly median to the spermathecal pore; ix—presetal, left side, in *bc;* x—presetal, right side, in *bc;* xi—presetal, left side, in *aa;* xii—presetal, left side, in *aa;* xiii—postsetal, median.
5. Segment viii—postsetal, right side, in *ab;* ix—presetal, left side, in *ab.*
6. Segment ix—presetal, right side, in *bc;* x—presetal, left side, in *bc.*

Internal anatomy.—Septa 5/6–8/9 are thickly muscular; 9/10 thin and displaced posteriorly. The last pair of hearts is in ix. There is a band of opaque material on each side of the dorsal blood vessel.

The gizzards are two, in xii–xiii (2 specimens) or three, in xii–xiv (4 specimens).

The testis sacs are ovoidal or kidney-shaped, in the latter case the concave side directed ventrally; in ix and x, unconstricted by 9/10. The vas deferens is short, rather thick, relative to size of the worm, in 9/10 with several loose loops into ix and x. The vas passes posteriorly on the parietes in segment x and into the body wall at a point slightly median to the entrance of the prostate into the parietes. The prostates are shortly club-shaped and erect; the entalmost portion may be two to three times as thick as the more ectal coelomic portion. Removal of the external glandular layer reveals a whitish, slenderly tubular, central body. In none of the specimens examined is there any widening of the ental end of the central body to correspond to the ental thickening of the external glandular layer.

Segment xi is reduced to a closed-off ovarian chamber of horseshoe-shape. The laterally flattened ovisacs appear to terminate, at first glance, in the region of segments xiv–xvii. If, however, the gut is carefully rolled over to one side a long slender rodlike body can be seen in the vicinity of the nerve cord on each side. This can be traced anteriorly into the region of segments xvii–xiv, where it passes dorsally at the side of the esophagus and gradually or abruptly merges into the wide portion of the ovisac. Thus, in reality, the ovisacs extend posteriorly into xxvi–xliii, xxvi (1 specimen), xxxvii and xli (1 specimen). In one worm the rodlike appendix of one side passes

over the gut but under the dorsal blood vessel and down onto the ventral parietes on the other side. In another specimen the appendices terminate in xx, but segments xxi–xxxvii are filled with ova while to the left of the nerve cord in xxvii–xxxvi and to the right in xxxvii–xliii is a posterior continuation of the appendix. Presumably the appendices were ruptured sometime previous to collection, releasing numbers of ova, after which the broken ends closed over.

The spermathecal duct is rather thick relative to the size of the animal and is 3–4 mm long. The atrium is finger-shaped, erect, on the posterior face of 7/8, ½–¾ mm high, length greater than thickness. The spermathecal duct passes into the atrium near the ental end but runs ventrally in the wall of the atrium nearly to the parietes before its lumen opens into the atrial lumen.

Convex, rounded glands project conspicuously into the coelomic cavities dorsal to the genital markings.

Remarks.—D. japonica was erected on two specimens from Japan, which are no longer available for study, as they were sectioned. In these circumstances it has been necessary to determine certain important specific characteristics from later specimens identified by the author of the species. There is at present little if any evidence against the correctness of the identification, though earlier accounts of the species leave much to be desired. Although Stephenson speaks of the prostates as "opening on the surface in groove 10/11" in his Indian specimens (1922, p. 126), he definitely figures a segmental location of the male pores (1923, p. 142). The ovisac appendages were not mentioned by previous authors, and hence it is of interest that Stephenson clearly shows a section through an appendix resting on the parietal floor of segment xii (1922, pl. 1, fig. 4, labeled sac).

Chen (1936, p. 291) maintains that the presence of the ovisac appendages and the location of the spermathecal pores are not of sufficient value to distinguish *japonica* from *grahami*. Even if Chen be correct with regard to these two points, other differences enumerated above (*vide* remarks under *D. grahami*) are important enough to justify the specific distinction of the two forms.

Just recently 6 aclitellate and juvenile specimens from Murree in the northwestern Himalayas have been examined. Although there are no free ova in segment xi and the ovisacs are obviously juvenile, two rodlike appendices are present in each of these specimens. The portion of the ovisac corresponding to that usually present in species of *Drawida* is as yet scarcely differentiated. The appendices extend into xxv in one specimen, into xviii in another, and in each specimen pass ventrally to the parietes near the nerve cord either on their own sides or after crossing to the opposite side under the dorsal blood vessel.

DRAWIDA SIEMSSENI Michaelsen

1910. *Drawida japonicus* f. *siemsseni* MICHAELSEN, Mitt. Naturhist. Mus. Hamburg, vol. 27, p. 50 (type locality: Foochow; type in the Hamburg Museum).

1931. *Drawida japonicus* f. *siemsseni* MICHAELSEN, Lingnan Sci. Journ., vol. 8, p. 157; Peking Nat. Hist. Bull., vol. 5, pt. 3, pp. 1, 7; Zool. Jahrb. (Abt. Syst.), vol. 61, p. 525.

Material examined.—From the Hamburg Museum: 1 specimen labeled "V 6333. *Drawida japonicus* Mich. f. *siemsseni.* Tiensin, Futschau."

External characteristics.—The genital markings and the male porophores are different from those of *D. japonica.* The clitellar glandularity appears to be only partially developed.

Remarks.—Forma *siemsseni* was erected on a single specimen that was distinguished from f. *typica* by the greater length, greater thickness, greater number of segments (said to be "sehr ungenau") and "ungefahr" 6 gizzards. The internal organs were removed in course of the original dissection and have been lost.

The "type" of f. *siemsseni* quite clearly is specifically distinct from *D. japonica*, but the species cannot be adequately characterized in the absence of the internal organs.

Genus PHERETIMA Kinberg

Within the genus *Pheretima* the prostomium, secondary annulation, gizzard, ovaries, oviducal funnels, and female pores do not provide characteristics that are of taxonomic importance. Reference to these has accordingly been omitted in succeeding pages. In each of the species described hereinafter, in absence of definite indication to the contrary, a gizzard is present in segment viii or in a region between septum 7/8 and either 9/10 or 10/11, while ovaries and oviducal funnels are present in segment xiii with a single female pore on xiv. As a rule, reference to color or pigmentation has been omitted, since many of the specimens have been bleached.

No reference has been made in the specific descriptions to the paired tufts of enteronephric pharyngeal nephridia at the sides of the gut in segments iv–vi. These nephridia apparently are always present and have been noted definitely in all the Chinese species examined except *P. choeina.* Absence of mention, in the laboratory notes, of these nephridia is probably merely an oversight. "Blood glands" in v or v and vi have been noted in the following species only: *P. antefixa*, *californica*, *fornicata*, *pectenifera*, *pingi*, *schmardae*, *szechuanensis*, *tuberculata*, and *vulgaris.* "Lymph glands" are probably present much more frequently than the occasional references in the specific descriptions indicate.

Intestinal caeca characterized by a single longitudinal axis are termed simple regardless of the depth of incisions on the dorsal and (or) ventral margins of the primary caecal evagination. Intestinal caeca with several longitudinal axes and with a rather characteristic glove-shaped conformation are termed compound.

PHERETIMA ABDITA Gates

1935. *Pheretima abdita* GATES, Smithsonian Misc. Coll., vol. 93, no. 3, p. 5 (type locality: Suifu, Szchewan; types in U. S. National Museum).

1936. *Pheretima abdita* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 11, p. 292 (after examination of types).

Material examined.—From Dr. Graham: 1 partially clitellate specimen labeled "Suifu"; 1 partially clitellate specimen labeled "Suifu, 1,000 feet, July 1925"; 14 clitellate specimens labeled "Chungking, 2,000 feet, May 6–27, 1930."

External characteristics.—Length, 80–140 mm. Maximum diameter, 3½–6 mm.

The setae begin on ii, on which segment there is a complete circle. The setae are small and regularly spaced, a trifle more widely separated dorsally than ventrally. There is no midventral break in the setal circles, a middorsal break when present of variable width. The setal numbers are as follows:

vi	vii	xvii	xviii	xix	xx	First dorsal pore
42	44	16	16	19	54	12/13
30	30	16	14	16	55	12/13
39	41	(1)	[2] 4	(1)	----------	12/13
39	41	16	16	18	61	12/13
41	43	16	13	16	56	12/13
39	39	16	15	16	56	11/12
38	39	15	17	17	69	12/13
38	36	14	15	16	58	12/13

[1] Wide gaps in setal circles, no pits visible in the gaps.
[2] Gaps with empty setal pits in the setal row.

The first dorsal pore is usually on 12/13.

The clitellum is annular, extending from 13/14 to 16/17 or not quite reaching to one or both of those limits; dorsal pores and intersegmental furrows lacking; setae present, at least ventrally, on all three segments.

The spermathecal pores are rather small, with puckered margins, widely separated, three pairs on 5/6–7/8.

The apertures of the male parietal invaginations on xviii are usually elongate-slitlike but may be somewhat rounded. The invaginations

are deep but confined to the parietes. The lateral wall of the invagination is thin, the ventral margin of the lateral wall liplike. On the median wall of the invagination is a large, circular, smooth, glistening area. The central portion of this area may be depressed into a vertical slit or groove. In the lateralmost or dorsalmost portion of this groove or slit the tip of the penis can usually be seen. The slit opens into a small, rounded, muscular bulb into which the penis is retracted, partially or completely. The smooth area on the median wall of the invagination may be raised in such a way as to have the appearance of a thickish ring around the base of the penis.

The everted parietal invagination has the appearance of a spheroidal knob. On the ventral face of this knob, in incomplete eversion, is a pitlike depression from which the tip of the penis protrudes. In complete eversion the entire length of the penis is visible. The penis is slenderly tubular, the tip rather pointed, the base slightly thicker; about 1 mm or slightly more in length.

The genital markings are presetal, paired, on xviii and xix. Each marking is transversely but shortly elliptical, about 5–9 intersetal intervals wide transversely, with a large, grayish, translucent, concave-depressed center and an opaque whitish rim. The lateral margins of the markings are just median to the apertures of the parietal invaginations, the median margins of a pair separated by a midventral space equal to 5–6 intersetal intervals. Anteroposteriorly the markings extend from just in front of the setae to the intersegmental furrow. The latter is slightly displaced toward the anterior end by the genital markings on all specimens on which the furrow is visible.

On each side of the body and extending from the margin of the clitellum posteriorly for several segments is a rather high ridge. The midventral region between these two ridges has a longitudinally rectangular appearance. The apertures of the male parietal invaginations are on the ventral faces of the longitudinal ridges, the genital markings on the median faces.

Internal anatomy.—Septa 5/6–9/10 are thickly muscular; septa 10/11–12/13 also muscular, especially 10/11, but not so thick as the anterior septa.

The esophagus in segments xiii or xiv–xv is strongly distended by soil, the esophageal wall very thin, sometimes actually transparent. The origin of the intestine is not quite clear but appears to be in xvi. The intestinal caeca are simple, long, slender, with smooth margins.

The paired hearts of ix–xiii all pass into the ventral trunk. In two specimens a pair of large heartlike commissures in ix connects

the supraesophageal and the ventrolateral vessels. These extra commissures are filled with blood and more readily visible than the empty commissures of ix connecting the dorsal and ventral trunks.

The single testis sac of x includes, in addition to the male funnels, testes and testicular material, the segmental portions of the esophagus, and the dorsal blood vessel, as well as the hearts of x. The sheet of tissue forming the boundary of the sac is attached anteriorly to 9/10 close to the esophagus at least dorsally and laterally. The wall of the sac is bulged out laterally on each side to a considerable extent by the testicular material. When the worm is first opened these lateral bulges look like a pair of fairly well developed seminal vesicles. The single testis sac of xi is either U-shaped or annular and is attached to 10/11 only close to the esophagus. The two dorsal limbs of a U-shaped sac may be symmetrical, the dorsal blood vessel between the ends of the limbs or one limb may be longer than the other, in which case the segmental portion of the dorsal blood vessel is within the longer limb. The annular testis sac is formed, presumably, by the fusion of the dorsal ends of the limbs of a U-shaped sac.

The seminal vesicles of xi are within the testis sac of the segment and are rather small. In some cases a small but definite, columnar, primary ampulla can be recognized. The vesicles of xii are larger than those of xi and usually asymmetrical. The larger vesicle, that of the left side, may extend posteriorly into contact with the prostate. The right vesicle may extend over onto the left side of xii as well as penetrating into xiii, or it may be confined to xii.

The prostates are broken up into a number of elongate finger-like lobes, and these lobes are not as a rule compacted into a solid mass. The prostatic duct is 5–6 mm in length, the middle portion thickest and bent into a C-shape. Just ectal and just ental to the C-portion there may be a tiny quirk or loop. Within the parietes the prostatic duct is widened to form a small bulbous body.

The spermathecae are small. The spermathecal duct is nearly as long as, or slightly longer than, the ampulla and is narrowed only very slightly within the parietes. The diverticulum is longer than the combined lengths of duct and ampulla and passes into the median face of the duct just below the ampulla. A very short ectal portion of the diverticulum is slenderly tubular, smooth, and glistening; the remaining portion of the diverticulum widened slightly, bent back and forth in a regularly but shortly zigzagged fashion, the successive limbs of the loops in contact and all in the same plane.

Within the parietes and sometimes projecting slightly into the coelomic cavity are glandular masses, one mass dorsal to each of the genital markings.

Remarks.—On the two partially clitellate Suifu specimens the spermathecal pores of 5/6 and 6/7 are nearer to the midventral line than are the pores of 7/8. The spermathecal setae of these two specimens are: vi/27–26, vii/26–26. In all other respects the Suifu worms are like those from Chungking.

P. abdita is close to *P. indica* and *P. gemella* but is distinguished from both by the restriction of the male invaginations to the parietes, by the muscularity of septa 8/9–9/10, by the genital markings on xviii and xix, and by the three pairs of spermathecae.

PHERETIMA ANTEFIXA Gates

1935. *Pheretima antefixa* GATES, Smithsonian Misc. Coll., vol. 93, no. 3, p. 6 (type locality: Suifu, Szechwan; types in U. S. National Museum).
1936. *Pheretima antefixa* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 11, p. 293 (after examination of types).

Material examined.—From Dr. Graham: 2 clitellate specimens labeled "Suifu, Szechwan, May 25, 1930"; 1 clitellate specimen labeled "Suifu, 1,000–1,300 feet, May 1–30, 1930"; 4 clitellate specimens labeled "Suifu, 1,000–1,400 feet, April 25–28, 1930"; 2 clitellate specimens labeled "south of Suifu, 1,000–1,500 feet, March 25, 1929."

External characteristics.—Length, 85–120 mm. Diameter, 3½–5 mm.

The setae begin on ii, on which segment there is a complete circle. The ventral setae of ii–ix are enlarged and widely spaced, occasionally the setae of viii–ix less enlarged than those of the anterior segments; the setae of x and succeeding segments definitely smaller and more closely spaced. Setae may be present ventrally on all clitellar segments or only on xvi, in the latter case the number varies from 7–16. The setal numbers are as follows:

viii	xvii	xviii	xix	xx	First dorsal pore
12	15	8	15	41	(?) 13/14
12	14	7	15	39	12/13
13	13	9	12	38	12/13
12	15	7	15	----------	(1)
14	16	9	17	----------	12/13
12	12	6	13	42	12/13
12	17	8	17	36	12/13
12	18	10	17	36	12/13
12	12	10	17	40	12/13

[1] No functional pores anterior to the clitellum (?).

The clitellum is annular, extending from 13/14 to 16/17, intersegmental furrows and dorsal pores lacking on eight specimens, functional dorsal pores present on one specimen.

The spermathecal pores are minute, widely separated, one pair, on 8/9.

In the setal circle of xviii on each side is a short transverse ridge, toward the lateral margin of which the minute male pore is located. Rarely the portion containing the male pore is definitely separated from the rest of the ridge as a distinct tubercle. On one specimen the ridge is represented only by a lateral male pore tubercle and a transversely oval tubercle at the approximate site of the median end of the ridge.

Each worm is characterized by the presence of a median, presetal genital marking at the midventral line on segments iii, iv, and v. The markings are circular, the diameter about equal to interval *aa;* the grayish, translucent, central area within the narrow, opaque, whitish rim is flat, convex, or concave.

Internal anatomy.—Septa 5/6–7/8 are thickly muscular; 8/9–9/10 lacking; 10/11–13/14 strengthened, 10/11–12/13 more than 13/14 but none of these so thick as the pregizzard septa.

The intestine begins in xv. The intestinal caeca are simple; the ventral margin is incised, the depths of the incisions decreasing anteriorly; the secondary lobes, short and rounded or longer and rather finger-shaped, are always directed ventrally. The dorsal margin may be slightly incised.

The single heart of ix may be on either the right or the left side. The hearts of x were not found in some specimens but were located in one worm on the anterior face of 10/11, where they were covered by connective tissue. The last pair of hearts is in xiii. The hearts of ix–xiii all pass into the ventral trunk.

There is a single ventral testis sac with a bilobed anterior margin projecting conspicuously from the anterior face of 10/11. There is also a single ventral testis sac in xi, but the anterior margin is so deeply indented that there appear to be two separate conical sacs with the bases of the cones on the anterior face of 11/12 while the pointed anterior ends are directed toward 10/11. The anterior points of the testis sac do not reach 10/11, but a tiny thread passes from the apex to 10/11. The buttonlike testes are in the apices of the sacs and not on the posterior face of 10/11. The seminal vesicles of xi and xii are in contact transversely over the dorsal blood vessel. Each vesicle may have a primary ampulla, definitely characterized as to color and surface appearance, and may be almost completely constricted off from the ventral lamina or deeply sunk into the dorsal

margin of the latter. The prostates extend through xvii–xxii. The prostatic duct is 3–5 mm long, straight or bent into a C-shape, with a tiny quirk just before passing into the parietes.

The spermathecal duct is much shorter than the ampulla and narrowed gradually in the parietes. The diverticulum, which is about equal to the combined lengths of the duct and ampulla or a trifle shorter, passes into the duct in or close to the parietes and comprises an ectal, slender, smooth-surfaced, firm stalk with a very narrow lumen and a more irregular, thinner-walled seminal chamber with a wider lumen. The elongate tubular seminal chamber may be twisted, almost straight, or with one or two very slight loops; it may be of about the same caliber throughout or the entalmost portion may be slightly widened.

Numbers of stalked glandular masses protrude into the coelomic cavity dorsal to each of the genital markings, the ducts passing into the parietes under the nerve cord. In some of the specimens what appears to be glandular material was found in the parietes around the spermathecal duct. No glandular material was found in the parietes in the region of the prostatic duct in the specimens that were carefully dissected.

Remarks.—Two worms were found on dissection to have a small spermatheca each in segment vii, with the duct passing into the parietes in the region of 7/8, though no spermathecal pore had been noted during the external examination. One of these spermathecae lacks a diverticulum. The other spermatheca has a diverticulum but with no spermatozoal iridescence, though seminal chambers of normal spermathecae from the same worm do have the iridescence.

P. antefixa is distinguished from all other bithecal species of *Pheretima* with spermathecal pores on 8/9 by the unpaired, presetal, median genital markings and their anterior location.

PHERETIMA ASPERGILLUM (E. Perrier)

1872. *Perichaeta aspergillum* E. Perrier, Nouv. Arch. Mus. Hist. Nat. Paris, vol. 8, p. 118 (type locality unknown; type in the Paris Museum).

1891. *Perichaeta aspergillum* Rosa, Ann. Nat. Hofmus. Wien, vol. 6, p. 403 (Amoy).

1899. *Amyntas aspergillum* Michaelsen, Mitt. Naturhist. Mus. Hamburg, vol. 16, p. 10 (Kowloon, near Hongkong).

1905. *Pheretima lauta* Ude, Zeitschr. wiss. Zool., vol. 83, p. 464 (type locality: Foochow; type in the Hamburg Museum).

1910. *Pheretima aspergillum* Michaelsen, Mitt. Naturhist. Mus. Hamburg, vol. 27, p. 102 (Foochow and Hongkong).

1929. *Pheretima paraglandularis* Fang, Sinensia, vol. 1, p. 15 (type locality: Chiu-chang, Ling-yung-shien, northwestern Kwangsi; types in Metropolitan Museum of Natural History, Nanking).

1930. *Pheretima aspergillum* Lin, Peking Nat. Hist. Bull., vol. 5, p. 15.

1931. *Pheretima aspergillum* MICHAELSEN, Lingnan Sci. Journ., vol. 8, p. 158 (excluding Formosa from the distribution ?).

1931. *Pheretima* (*Ph.*) *siemsseni* (part)+*P. lauta*+*P. aspergillum*+*P. paraglandularis* MICHAELSEN, Peking Nat. Hist. Bull., vol. 5, pt. 3, pp. 2, 3, 17 (type locality of *siemsseni:* Foochow, Fukien; type in the Hamburg Museum).

1931. *Pheretima siemsseni* MICHAELSEN, Zool. Jahrb. (Abt. Syst.), vol. 61, p. 571 (part).

1931. *Pheretima paraglandularis* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 7, p. 159 (examination of type).

1932. *Pheretima lauta* GATES, Lingnan Sci. Journ., vol. 11, p. 513.

1935. *Pheretima aspergillum* GATES, Smithsonian Misc. Coll., vol. 93, no. 3, p. 7.

Material examined.—From the Hamburg Museum: 3 specimens (A) labeled "*Pheretima aspergillum* E. Perr. China. Futschau"; 1 specimen (B) from a tube[1] labeled "*Pheretima* (*Ph.*) *siemsseni* Mich. Originale, China, Futschau. Consul Siemssen leg."; and 1 specimen (C) labeled "V 10472, *Pheretima lauta* Ude. China, Futschau. Consul Siemssen." From the U. S. National Museum: 7 macerated clitellate specimens labeled "Foochow, China. C. R. Kellogg, collector."

External characteristics.—The setae begin on ii, on which segment there is a complete circle. The setae are small and regularly spaced; no definite midventral break in the setal circles; a middorsal break, when present, variable in width. The setal numbers are as follows:

viii	xvii	xviii	xix	xx	Specimen
27	34	13	35	88	A
29	33	18	38	97	A
27	32	[1] 7	34	84	A
27	31	16	30	[2] 70	B
31	33	14	32	----------	C

[1] Gaps in the setal row.
[2] Gaps in setal circle in which setae may have been present.

The first dorsal pore is on 11/12 (4 specimens—A and B).

The clitellar glandularity is only slightly developed on the three specimens of A; the clitellar coloration dark reddish, extending from 13/14–16/17; intersegmental furrows and dorsal pores present; setae visible at least ventrally. The clitellum of specimen C is also probably not fully developed. The clitellum of specimen B appears to be more completely developed, but there are slight traces of the intersegmental furrows ventrally and also ventral setal pits in which no setae can be seen.

[1] In addition, this tube contains a specimen of *P. robusta* and an aclitellate, softened, and unidentifiable specimen of *Pheretima* sp.

The spermathecal pores are minute, widely separated, on tiny protuberances; two pairs, on 7/8–8/9.

At the center of each male pore area on xviii of specimens A is a narrow transverse ridge, roughened or finely lobulated. On the lateralmost portion of this ridge is a tiny papilla on which is the minute male pore. No setae are visible on the ridge, which is in line with the setal circle. Just anterior and just posterior to each of these male pore ridges are two transverse rows of tiny, very short, columnar tubercles or papillae; the ventral face of each column is flattish or slightly depressed, the central area grayish, translucent, and surrounded by a narrow, opaque, whitish rim. The number of the papillae in each male pore region varies from 15 to 17. The body wall immediately in front of and just behind the male pore ridge together with the tubercles thereon is slightly depressed. The whole of the region just described is surrounded by 4–6 concentric furrows; each furrow outlines a transversely oval area with the more pointed portion mesially. The furrows reach beyond the limits of xviii, slightly invading segments xvii and xix.

On specimen B the male pore ridges are not clearly visible; there are only 10–13 markings, none of which have a columnar appearance; the concentric furrows outline longitudinally oval areas.

On specimen C the male pore ridges are also not clearly visible, but the concentric furrows are like those on specimens A. The genital markings are closely crowded and, as a result of maceration, are difficult to count; about 17 markings on each area.

On Kellogg's specimens, the number of markings on a male area varies from 10 to 23, the transverse ridges visible. The male pore tubercles are slightly lateral to, and usually a trifle larger than, the genital markings.

The preclitellar genital markings (A) are very similar to those of the male pore region but do not have a columnar appearance and are located slightly median to the spermathecal pores, in transverse rows of 2–5, one row each on the anteriormost margins of viii and ix and the posteriormost margins of vii and viii. The genital markings may be entirely lacking in the vicinity of a particular spermathecal pore. On specimen B the preclitellar genital markings are (probably) almost entirely lacking. There is, however, a single very definitely outlined marking on the posteriormost margin of vii on the right side just median to the spermathecal pore of 7/8. On specimen C the genital markings are quite characteristic, each row with 5–7 markings. On Kellogg's specimens the number of markings in a row varies from 0 to 8.

Internal anatomy.—(The internal organs had been removed from the anterior end of specimen B. Specimen C had been dissected, the

internal organs in part disarranged and softened. Five of Kellogg's specimens had also been opened.)

Septa 5/6–7/8 are thickly muscular, as are 10/11–13/14; 8/9–9/10, lacking.

There is a small but very distinct glandular collar (smooth, without lobulations) on the esophagus just behind the gizzard (3 specimens). The intestine begins in xv (3 specimens). The intestinal caeca are simple, more or less finger-shaped, and directed anteriorly. Both dorsal and ventral margins may be incised. The incisions vary from fairly slight to deep. The height of the secondary lobes may be much less than the dorsoventral thickness of the primary portion of the caecum or greater. In the latter case the secondary lobes, or caeca, are finger-shaped, and the entire caecum might almost be regarded as compound. The secondary lobes, however, are not directed anteriorly as in a glove-shaped compound caecum, but dorsally or ventrally. If both dorsal and ventral margins are deeply incised the depth of the incisions decreases passing posteriorly on the dorsal margin but increases on the ventral margin passing posteriorly.

The last pair of hearts is in xiii (3 specimens). There may be a single commissure belonging to ix on the right or the left side, or a pair of commissures. The hearts of x are closely bound against the anterior face of 10/11 by connective tissue and if empty may be difficult to find. All hearts of ix–xiii pass into the ventral vessel.

The testis sacs of x and xi are unpaired and ventral (A, C, and Kellogg's specimens). The seminal vesicles of xi and xii are in contact transversely above the dorsal blood vessel. Each vesicle is provided with a primary ampulla the height of which may equal the height of the ventral lamina. The primary ampulla may be conical or columnar; the base may be merely constricted off from the ventral lamina, or the base may be wedge-shaped and sunk into the dorsal margin of the ventral lamina. In two specimens the primary ampullae are filled with parasitic masses, while none of these masses are present in the ventral portions of the vesicles. There are paired pseudovesicles in xiii and xiv, the vesicles of xiii about half the size of the vesicles in xii but about twice the size of the vesicles of xiv (3). The pseudovesicles of xiii of one specimen contain parasitic masses.

The prostates extend through xvii or xviii–xix or xx. The prostatic duct is 13–16 mm long, tapering gradually at each end, bent in an **S** or **W** shape. A middle portion about 7–9 mm in length is much thickened. In Kellogg's specimens the ducts are **J**- or **U**-shaped, the ectal limb of a loop thickened.

The spermathecal duct is stoutish, narrowed only in the outermost layers of the parietes. The diverticulum is about as long as or longer than the combined lengths of duct and ampulla.

An ental portion of the spermathecal diverticulum is usually elongate-ovoidal and definitely marked off from the remainder of the diverticulum. An ental portion of the slenderer part of the diverticulum, is, like the ovoidal part, filled with sperm and often looped into a regular zigzag, the limbs of the loops short and in apposition. The stalk portion of the diverticulum is not marked off externally from the looped portion of the seminal chamber.

Associated with each preclitellar or postclitellar genital marking is an ovoidal glandular mass. This mass may project slightly into the coelomic cavity or may be bound down to the parietes or be located within the parietes between longitudinal muscle fibers. The stalks, which are narrower than the glands, may or may not be visible within the coelomic cavity. The stalked preclitellar glands are readily recognizable in the coelomic cavity of specimen C. Only one stalked preclitellar gland is visible in the coelomic cavity of specimen B.

Remarks.—Lin's specimens were from Amoy and were identified by Michaelsen. According to Lin the number of setae on segments xx–xxi varies from 86 to 93.

P. paraglandularis is so very similar to *P. aspergillum* with regard to a number of structures of major systematic importance that there can be little if any doubt that the two are synonymous (types have not been available for study). However, in *P. paraglandularis*, according to Fang, the male pores are large slits; there are "moderate" copulatory chambers, each containing an elongate genital papilla; septum 8/9 is thickened, only 9/10 is lacking; the gizzard is between septa 8/9 and 10/11 and accordingly belongs morphologically either to ix or x; the intestinal caeca orginate in xxv and extend only through one segment, there are two pairs of testis sacs, the conjoined transverse pairs connected with each other anteroposteriorly. All these rather unusual characteristics are doubtless the result of errors in observation or interpretation. It is scarcely necessary to discuss all these errors. The gizzard is always in segment viii in the genus *Pheretima.* Fang has mistaken septa 5/6–7/8 for septa 6/7–8/9. The elongate genital papilla is doubtless the transverse ridge on the male area.

Fang's figure of a male genital area would do quite well for that of one of the Hamburg specimens if the transverse ridge were lobulated instead of smooth and with genital markings. An intestinal caecum of one of the Hamburg specimens is very much like the figure of the caecum in Fang's paper.

Chen examined Fang's specimens but failed to correct the errors in Fang's account. According to Chen the hearts of x are lacking;

possibly the missing pair was overlooked owing to the coverage by connective tissue.

Specimen C is cut into two portions. The combined lengths of these parts is about 145 mm. The number of segments is 135 or 136. The posterior half of the worm is characterized by an alternate brown and white banding, especially marked on the dorsum, the setal circles on rather narrow, whitish bands, between successive white bands a broader, brownish, intersetal band. These three characteristics enable the identification of the Hamburg specimen numbered V 10472 as the holotype of *P. lauta*.

PHERETIMA BUCCULENTA Gates

1935. *Pheretima bucculenta* GATES, Smithsonian Misc. Coll., vol. 93, no. 3, p. 7 (type locality: Szechwan; type in U. S. National Museum).

1936. *Pheretima fangi*+*P. bipapillata* (not *P. bipapillata* Ude, 1905)+*P. bucculenta* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 11, pp. 275, 286, 294 (type locality of *fangi:* Suifu, Szechwan; of *bipapillata:* Chungking, Szechwan; types of both in the Museum of the Biological Laboratory of the Science Society of China).

Material examined.—From Dr. Graham: 1 clitellate specimen labeled "Szechwan, 3,000–4,000 feet, July 9–11, 1930."

External characteristics.—Length, 135 mm. Diameter, 6 mm.

The setae begin on ii, on which segment there is a complete circle. There is no definite midventral break in the setal circles; a middorsal break of variable width may be present. The setal numbers are vi/22, vii/22, viii/25, xvii/16, xviii/20, xix/20.

The first dorsal pore is on 12/13.

The clitellum is annular, extending from 13/14 to 16/17; dorsal pores and intersegmental furrows lacking; no setae visible.

The spermathecal pores are minute, four pairs, on 5/6–8/9.

The male pores are minute, each pore on a tiny conical tubercle in the dorsalmost portion of a parietal invagination. The parietal invaginations are deep, slitlike, with longitudinal, narrow apertures. The lateral wall is thin, and its ventral margin is liplike. Setae are lacking on the lateral wall of the invagination.

There is a pair of genital markings on xviii. Each marking is transversely oval, 4–6 intersetal intervals wide, immediately anterior to the setae, the lateralmost portion within the parietal invagination and covered over by the lateral lip. The markings are flat-surfaced, slightly protuberant, sharply demarcated, grayish, and widely separated from each other. In addition to these quite definite markings, there are in the parietal invaginations 1–3 less definite whitish patches of varying shape and size.

Internal anatomy.—Septa 6/7–7/8 and 10/11–11/12 are thickly muscular; 12/13 muscular; 8/9 present only ventrally; 9/10 lacking.

The intestine begins in xv. The intestinal caeca are elongate, simple, with 6–8 very definite but short and stumpy, rather broad lobes on the ventral margin, length of lobes less than dorsoventral diameter of the main portion of the sac.

There is a pair of hearts belonging to ix. The last pair is in xiii. The hearts of x are large, filled with blood, and not held against septum 10/11. All hearts of ix–xiii pass into the ventral vessel.

The testis sacs of x and xi are unpaired and ventral. The seminal vesicles of xi and xii are medium-sized vertical bodies, in contact transversely over the dorsal blood vessel. There is a pair of small club-shaped pseudovesicles in xiii. The prostates extend through xvii–xviii. The prostatic duct is about 4 mm in length, bent into a U-shape, the ectal half thicker than the ental half.

The spermathecal duct is rather slender, about equal in length to the ampulla from which it is not sharply marked off, only slightly narrowed within the parietes. The diverticulum passes into the anterior face of the duct close to the parietes and is short, slender, the ental portion bent in a regularly zigzagged fashion, the loops all in the same plane. The diverticula are rather small and may possibly not be fully developed.

In the parietes dorsal to each genital marking is a glandular mass that projects conspicuously into the coelomic cavity, the dorsal face of the mass rather conical.

Remarks.—In the coelomic cavities, the seminal vesicles, and the walls of some of the blood vessels there are numbers of parasites, which may have been responsible for a retardation in the development of the spermathecae and in particular of the spermathecal diverticula. Other organs appear to be normal.

The male parietal invaginations are very similar to those of *P. tschiliensis*, *P. praepinguis*, and *P. paeta*.

P. bucculenta is distinguished from other octothecal Chinese species of *Pheretima* by the combination of superficial spermathecal pores and deeply invaginate male pores.

P. fangi is distinguished from *bucculenta*, according to Chen (1936, p. 278), by the larger size of the genital marking in the male pore invagination, the larger size of the male pore invagination, the stout hearts of x, the coiling of the spermathecal diverticulum, and "many other characters." Slight differences in size of genital markings or of hearts, in depth of the male pore invaginations (even if existent) as well as coiling of a spermathecal diverticulum are not acceptable criteria of specific distinctness in the genus *Pheretima*. The "many other characters" (of specific value) are nonexistent so far as can be discovered from the description given by Chen. As was noted above, the type of *bucculenta* was heavily parasitized and

may not have been quite normal (*vide* note on spermathecal diverticula in description above).

P. bipapillata (preoccupied by *bipapillata* Ude in 1905) is not distinguished either from *bucculenta* or *fangi* by any characteristics of specific value.

PHERETIMA CHOEINA Michaelsen

1927. *Pheretima choeina* MICHAELSEN, Boll. Lab. Zool. Portici, vol. 21, p. 85 (type locality: Lo-choei-Tong, Yunnan; type in the Hamburg Museum).

1931. *Pheretima* (*Ph.*) *choeina* MICHAELSEN, Lingnan Sci. Journ., vol. 8, p. 158; Peking Nat. Hist. Bull., vol. 5, pt. 3, p. 3.

Material examined.—From the Hamburg Museum: Contents of a tube labeled "V 10424. *Pheretima choeina* Mich. Lo Choei Tong, Yunnan, 2.3.35. F. Silvestri leg. Michaelsen ded." The tube contains only a few internal organs, including two spermathecae.

Remarks.—The seminal vesicles of xi and xii are small, little if at all larger than the pseudovesicles of xiii. The left anterior vesicle is smaller than the others. The appearance of the seminal vesicles and in particular of that of the left side of xi together with the absence of the setae on x ("Borsten am 10. Segment fehlend, wenn nicht sehr klein") may perhaps be taken as evidence that the type is abnormal.

PHERETIMA CALIFORNICA Kinberg

1867. *Pheretima californica* KINBERG, Öfv. Vet.-Akad. Förh. Stockholm, vol. 23, p. 102 (part) (excluding octothecal specimens; type locality: Sausalito Bay, Calif.; types in the Stockholm Museum).

1912. *Pheretima browni* STEPHENSON, Rec. Indian Mus., vol. 7, p. 274 (part) (excluding sexthecal specimens; type locality: Tengyueh, Yunnan; types in the British Museum and the Indian Museum).

1927. *Pheretima modesta* MICHAELSEN, Boll. Lab. Zool. Portici, vol. 21, p. 88 (type locality: Yi-Leang, Yunnan; type in the Hamburg Museum).

1931. *Pheretima browni* MICHAELSEN, Lingnan Sci. Journ., vol. 8, p. 158.

1931. *Pheretima* (*Ph.*) *browni* + *P. kiangensis* MICHAELSEN, Peking Nat. Hist. Bull., vol. 5, pt. 3, pp. 3, 21 (type locality of *kiangensis:* Soochow, Kiangsu; types in the Hamburg Museum).

1931. *Pheretima kiangensis* MICHAELSEN, Zool. Jahrb. (Abt. Syst.), vol. 61, p. 558.

1931. *Pheretima* (*Ph.*) *hesperidum* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 7, p. 137 (part) (excluding from synonymy *loehri* Michaelsen, 1899, and possibly though not probably *sandvicensis* Beddard, 1896; Szechwan).

1933. *Pheretima hesperidum* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 7, p. 275 (Kiangsu, Chekiang, Anhwei, Kiangsi, Hupei, Hunan).

1935. *Pheretima hesperidum* CHEN, Bull. Fan Inst. Biol. Peiping, vol. 6, p. 33 (Hongkong).

1935. *Pheretima modesta* GATES, Smithsonian Misc. Coll., vol. 93, no. 3, p. 12.

1935. *Pheretima californica* GATES, Lingnan Sci. Journ., vol. 14, p. 452.

1936. *Pheretima californica* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 11, p. 270 (Szechwan).

THE FOLLOWING PLACED DOUBTFULLY IN SYNONYMY:

1896. *Perichaeta sandvicensis* BEDDARD, Proc. Zool. Soc. London, 1896, p. 203 (Hongkong).

1931. *Pheretima hesperidum* MICHAELSEN, Lingnan Sci. Journ., vol. 8, p. 159 (excluding *Amyntas loehri* Michaelsen).

1931. *Pheretima* (*Ph.*) *hesperidum* MICHAELSEN, Peking Nat. Hist. Bull., vol. 5, pt. 3, p. 2 (excluding *Amyntas loehri*).

Material examined.—From the Hamburg Museum: 1 specimen labeled "V 10423. *Pheretima modesta* Mich. Yi Leang, SW. China. F. Silvestri leg. 24.2.1925"; 4 specimens (A) labeled "*Pheretima kiangensis* Mich. (= *Ph. kiangsuensis* Chen) China, Soochow, Biol. Anst. Soochow 1/." From the U. S. National Museum: 3 specimens (B) labeled "*Pheretima hesperidum*, Nanking, China. Ident. by Y. Chen." From Dr. Graham: 5 specimens (C) labeled "Szechwan, 7,000 feet, August 29, 1928"; 2 clitellate specimens labeled "At Lo-Gu in the Ningyuenfu prefecture, 6,500 feet, July 22–23, 1928"; 1 clitellate specimen labeled "Suifu, 1,200–2,000 feet, October 30–November 1, 1928"; 1 clitellate specimen labeled "Suifu, 1929."

External characteristics.—The setal numbers of several specimens are as follows:

viii	xvii	xviii	xix	xx	Specimens
20	16	10	17	----------	A
18	22	12	19	59	A
15	18	12	21	56	A
16	20	11	22	----------	A
15	19	12	17	----------	B
[1] 17	[1] 16	[1] 10	[1] 20	----------	B
16	[1] 18	[1] 9	20	----------	B
17	18	14	19	44	C
17	22	16	20	43	C
18	23	17	22	47	C
19	22	14	22	59	C
17	18	12	17	45	C

[1] Gaps in setal rows, setal pits present in gaps, setae possibly pulled out in removing cuticle.

The apertures of the copulatory chambers are transversely slit-like, the margins of the apertures minutely lobulated. The copulatory chambers are completely everted in the type of *modesta*. The apertures of the copulatory chambers may gape open so that the male pores are visible.

Internal anatomy.—The intestinal caeca are simple, the ventral margins usually with several slight incisions. The typhlosole begins just behind the intestinal caeca and extends into the gut lumen as a low but thin and bladelike ridge.

There is a pair of hearts belonging to ix in 2 specimens; the single heart of ix on the left side (4 specimens), on the right side (3 specimens). The last pair of hearts is in xiii (9 specimens). All hearts of ix–xiii pass into the ventral blood vessel (4 specimens).

The testis sacs are unpaired and ventral (9 specimens), the sac of x often with a bilobed anterior margin.

The prostates extend through xvii–xix or xx. The prostatic duct is 2–4 mm long. An ental portion, varying in length from 2 to 3 mm, is thickly muscular, nearly straight or slightly bent into a sort of crescentic curve. An ectal portion, about 1 mm in length, is very slender but firm and bent into 1–3 tiny U-shaped quirks, which are covered over by connective tissue; only the thickly muscular portion of the duct visible on first opening the worms.

The copulatory chambers, when completely retracted, protrude rather conspicuously into the coelomic cavity. A very large portion of this coelomic protuberance is composed of connective tissue and the tiny ectal quirks of the prostatic duct. In those specimens on which the apertures of the chambers gape open the lumen of a chamber does not extend internally beyond the level of the coelomic face of the parietes and the male pore chamber appears to be simply an invagination of the parietes. In 2 specimens with chambers (apparently) fully retracted and with chamber apertures shut tight the lumen of the chamber appears to extend internally dorsal to the level of the coelomic face of the parietes though only slightly, while ectally the lumen is narrowed as if by a sphincter. The male pore invagination is accordingly termed a copulatory chamber. The actual protuberance (of the chamber not including the quirks of the prostatic duct and the connective tissue) is, however, so slight that it may be preferable to call the chamber a parietal invagination.

The spermathecal duct is narrowed in the parietes, the thicker coelomic portion about as long as or slightly shorter than the ampulla. An ectal portion of the ampulla is so firmly bound by connective tissue around the ental portion of the duct that the duct appears to be invaginated into the lumen of the ampulla. The diverticulum comprises a short stalk, which may be nearly as thick as the duct, and a longer and slightly thicker seminal chamber. The latter is nearly straight, twisted, looped, or bent in various ways.

Remarks.—The U. S. National Museum specimens from Szechwan are brittle and broke into pieces in the course of dissection.

There is nothing whatever in Beddard's account of his *sandvicensis* to indicate specific distinction from *californica* (types and the Hongkong specimens). If Beddard's specimens cannot be found, *sandvicensis* will have to be regarded as a synonym of *californica*.

PHERETIMA DIFFRINGENS (Baird)

1869. *Megascolex diffringens* BAIRD, Proc. Zool. Soc. London, 1869, p. 40 (type locality: Plas Machynlleth, North Wales; types in the British Muesum).
1912. *Pheretima divergens* var. *yunnanensis* STEPHENSON, Rec. Indian Mus., vol. 7, p. 274 (type locality: Tengyueh, Yunnan; type in the Indian Museum).
1931. *Pheretima (Ph.) divergens* MICHAELSEN, Lingnan Sci. Journ., vol. 8, p. 158 (part) (excluding Japanese distribution); Peking Nat. Hist. Bull., vol. 5, pt. 3, p. 2 (part) (excluding Japanese distribution).
1931. *Pheretima (Ph.) heterochaeta* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 7, p. 123 (Szechwan).
1932. *Pheretima divergens* GATES, Lingnan Sci. Journ., vol. 11, p. 511.
1933. *Pheretima heterochaeta* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 9, p. 234 (Kiangsu, Chekiang, Kiangsi, Anhwei).
1935. *Pheretima heterochaeta* CHEN, Bull. Fan Inst. Biol. Peiping, vol. 6, p. 34 (Hongkong); Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 11, p. 121 (Fukien).
1935. *Pheretima mirabilis* GATES, Smithsonian Misc. Coll., vol. 93, no. 3, p. 12.
1935. *Pheretima diffringens* GATES, Lingnan Sci. Journ., vol. 14. p. 452.
1936. *Pheretima heterochaeta* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 11, p. 270 (Szechwan).

Material examined.—From the Indian Museum: 2 fragments labeled "*Pheretima divergens* variety *yunnanensis* Steph. Tengyueh, Yunnan. J. Coggin Brown." From the British Museum: 1 specimen from a tube labeled "*Pheretima barbadensis* 1904.10.5.1219.1228. Hongkong. coll. Beddard" and 1 specimen from a tube labeled "*Pheretima morrisi* 1904.10.5.453. Hongkong. coll. Beddard." From the U. S. National Museum: 1 specimen from a tube labeled "*Pheretima corrugata* Chen (paratypes), Kia-Ting, Szechuan. Y. Chen." From Dr. Graham: 1 clitellate specimen labeled "Mar Hai-Tang, 6,000–8,000 feet, April 14, 1928"; 2 clitellate specimens labeled "Near Mupin, 3,000–4,000 feet, July 8, 1929"; 1 clitellate specimen labeled "Near Yachow, 1,400–1,800 feet, July 3–5, 1930"; 2 clitellate specimens labeled "Mupin, 3,500–5,000 feet, July 1, 1929"; 1 clitellate specimen labeled "Kangshien, 1,300–2,000 feet, October 28–29, 1928"; 2 clitellate specimens labeled "Between Kiating and Yachau, July 8–11, 1928"; 1 clitellate specimen labeled "Suifu, 1,400 feet, April 18, 1925"; 1 clitellate specimen labeled "South of Suifu, 1,100–1,400 feet, May 14, 1924"; 1 clitellate specimen labeled "Between Gin Keo Ho and Dawei, 1,300–5,000 feet, August 1–2"; 1 clitellate specimen labeled "Tatsienlu, 12,000 feet, July 7–9, 1923"; 1 clitellate specimen labeled "Tatsienlu, August 2–4, 1923."

In the Szechwan specimens prostatic ducts are present, but prostates are entirely lacking (8 specimens), only one prostatic duct present and no prostates (1 specimen), characteristic ducts and rudimentary prostates present (1 specimen), a medium-sized prostate and a normal duct on one side, a prostatic duct only on the

other side (1 specimen), a pair of medium-sized prostates with ducts (1 specimen), a pair of fully developed prostates with ducts (2 specimens).

Remarks.—Stephenson's specimen of *P. divergens* is quite clearly *P. diffringens.* One of the three paratypes of Chen's *P. corrugata* also is rather obviously to be referred to *P. diffringens.*

A specimen from Tatsienlu with normal prostates is heavily infested with nematodes. The worm has a pair of large pseudovesicles in xiii.

PHERETIMA EXILIS Gates

1935. *Pheretima exilis* GATES, Smithsonian Misc. Coll., vol. 93, no. 3, p. 7 (type locality: Suifu, Szechwan; type in U. S. National Museum).
1936. *Pheretima exilis* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 11, p. 294 (after examination of type).

Material examined.—From Dr. Graham: 2 clitellate specimens labeled "Suifu, Szechwan, 1929."

External characteristics.—Length, 68–85 mm. Diameter, 2–2½ mm.

The setae begin on ii, on which segment there is a complete circle, and are small and closely crowded. There is no definite midventral gap in the setal circles; a slight middorsal gap may be present. There are six ventral setae on segment xvi. Other setal numbers are as follows:

vi	xvii	xviii	xix	xx
39	15	8	13	50
----------	10	8	11	----------

The first dorsal pore is on 12/13.

The clitellum is annular, extending from 13/14 to 16/17; dorsal pores and intersegmental furrows lacking.

The spermathecal apertures are minute, widely separated, on tiny transversely oval areas; two pairs. The pore areas appear to be on the posterior margins of v and vi; ducts of several spermathecae were pulled out from the parietes but without obtaining definite evidence as to the exact location of the pores with relation to the intersegmental furrows.

The male pores are minute, each pore on a smooth, glistening, indistinctly demarcated area, the central portion of which is slightly depressed, the depression with an open circular aperture at the bottom of which the male pores are readily visible.

The genital markings are two pairs on xvii and xix, each marking having a thick opaque rim and a grayish, concave, circular, central portion. The markings appear to be postsetal in position, but the setae are lacking on both xvii and xix immediately in front of the markings. Each marking is about 6 intersetal intervals wide transversely and is separated from the marking of the opposite side by a midventral space about equal to 13–15 intersetal intervals.

Internal anatomy.—Septa 5/6–7/8 are thickly muscular; 8/9 represented only by a thin ventral rudiment; 9/10 lacking; 10/11–12/13 membranous but slightly strengthened.

The intestine begins in xv. The intestinal caeca are simple with smooth margins, short, extending through 2–3 segments.

There is a pair of hearts belonging to ix. The last pair of hearts is in xiii.

There is a pair of testis sacs on the anterior face of 10/11; no transverse connection between the sacs noted. The testis sac or sacs of xi extend dorsally at the sides of the esophagus to the dorsal blood vessel and contain the hearts of xi as well as the seminal vesicles of that segment. The seminal vesicles, paired in xi and xii, are small vertical bodies. Prostates are entirely lacking in one specimen, extending through xvii–xx in the other. In the first specimen the prostatic duct is represented only by a short, soft, whitish widening of the vas deferens just as it passes into the parietes. In the other specimen the prostatic ducts are short and soft, bent into a sort of **C**-shape but with a tiny quirk in the duct at each end of the **C**.

The spermathecae of both specimens are probably abnormal; the duct-ampulla portion of the apparatus appears to be very rudimentary, while the diverticular portion seems, relatively, to be hypertrophied. The diverticulum passes into the median face of the duct-ampulla rudiment.

There is glandular material in the parietes dorsal to each genital marking, the material projecting slightly into the coelomic cavity.

Remarks.—The types are almost certainly abnormal (spermathecae in both specimens and prostates in one specimen). Examination of normal specimens may enable recognition of further abnormalities in the types.

At present *P. exilis* can be distinguished from other quadrithecal Chinese species of *Pheretima* with spermathecal pores on 5/6–6/7 by the inclusion of the seminal vesicles of xi within the posterior testis sacs.

PHERETIMA FLEXILIS Gates

1935. *Pheretima flexilis* GATES, Smithsonian Misc. Coll., vol. 93, no. 3, p. 7 (type locality: Between Gin Keo Ho and Dawei, Szechwan; type in the U. S. National Museum).

1936. *Pheretima flexilis* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 11, p. 295 (after examination of type).

Material examined.—From Dr. Graham: 1 clitellate specimen labeled "Between Gin Keo Ho and Dawei, 1,300–5,000 feet, August 1–2."

External characteristics.—Length, 40 mm. Diameter, 2 mm.

The setae begin on ii, on which segment there is a complete setal circle. Setal numbers: vii/16, viii/16, xvii/10, xviii/*ca.* 10, xix/11.

The first dorsal pore is probably on 13/14.

The clitellum is annular, extending from 13/14 to 16/17; intersegmental furrows, dorsal pores, and setae lacking.

The male pores are minute, at the centers (probably) of tiny transversely oval areas in the setal circle of xviii. Each male pore area is surrounded by several concentric furrows.

The spermathecal pores are minute, on tiny, transversely oval, glistening areas; three pairs, on 6/7–8/9.

The genital markings are median, unpaired, tiny, circular tubercles, each with a definite rim and a grayish-translucent center; presetal on viii, slightly nearer to the setae than to 7/8; postsetal on xvii, close to the setae; postsetal on xviii, close to the setae.

Internal anatomy.—Septa 5/6–6/7 are strengthened; no septa thickly muscular; 8/9–9/10 lacking.

The intestine begins in xv. The intestinal caeca are simple; the margins smooth except for septal constrictions.

The single heart of ix is on the right side. The last pair of hearts is in xiii.

The testis sac of x is horseshoe-shaped, on the anterior face of 10/11; the ventral ends of the sac in contact but apparently not united. The testis sacs of xi are paired, erect, more or less ovoidal, vertical bodies. The lower end of a sac is on the ventral parietes, the upper end reaching or almost reaching the dorsal blood vessel. Each sac encloses a heart, a male funnel, and a seminal vesicle, as well as testicular coagulum. The testes were not identified. The seminal vesicles of xii are large, in contact transversely above the dorsal blood vessel; extending through xiii on the left side but on the right side pushing 12/13 and 13/14 back into contact with 14/15. The prostates extend through segments xvi–xx. The prostatic duct is just over 1 mm in length, glistening, erect in the coelom, practically

straight except for a very short, slender, ental portion that is not glistening and which is bent into a tiny quirk.

The spermathecal duct is very short, about one-fourth (or less) the length of the ampulla, narrowed in the parietes to a tiny conical point. The diverticulum comprises a short slender stalk and a much longer, slightly wider, thin-walled seminal chamber. The latter is variously bent, twisted, or looped.

The genital marking glands are smooth and ovoidal; the coelomic portion of the stalks fairly long and glistening.

Remarks.—The body wall is so transparent in places that exact enumeration of the setae is difficult.

P. flexilis is distinguished from *P. hupeiensis* (Michaelsen, 1895) by the absence of septa 8/9–9/10 and from *P. leucocirca* Chen, 1933, by the characteristics of the testis sacs and the included seminal vesicles and hearts.

PHERETIMA FORNICATA Gates

1935. *Pheretima fornicata* GATES, Smithsonian Misc. Coll., vol. 93, no. 3, p. 9 (type locality: Tatsienlu, Szechwan; types in the U. S. National Museum).

1936. *Pheretima fornicata* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 11, p. 296 (after examination of type).

Material examined.—From Dr. Graham: 3 clitellate specimens labeled "Tatsienlu, 12,000 feet, July 7–9, 1923"; 1 clitellate specimen in poor condition labeled "Between Gin Keo Ho and Dawei, 1,300–5,000 feet, August 1–2."

External characteristics.—Length, 78–90 mm (100 mm, Dawei specimen). Diameter, 4–6 mm.

The setae begin on ii, on which segment there is a wide dorsal gap in the setal circle. There is a small but fairly regular, midventral break in the setal circles; the middorsal gap usually larger but variable in width. The setal numbers are as follows:

vi	vii	viii	xvii	xviii	xix	x
17	19	18	13	9	13	--------
[1] 16	20	[1] 19	14	9	12	56
24	21	23	14	14	15	--------
26	[1] 23	27	19	13	[1] 15	--------

[1] In addition setal pits in which no setae were definitely recognized.

The first functional dorsal pore is on 12/13 on each specimen, but there is a porelike marking on 11/12.

The clitellum is annular, extending from 13/14 to 16/17; intersegmental furrows and dorsal pores lacking; no setae visible. There are functional dorsal pores on 13/14 and 16/17.

The spermathecal apertures are minute, four pairs on 5/6–8/9, on tiny, grayish, transversely oval markings. The intersegmental furrows are not visible on one specimen in the vicinity of the spermathecal pores. On another specimen the ventral body wall is strongly contracted, making observations on the position of the pores difficult. On the remaining specimen, it appeared at first glance as if the spermathecal apertures were on the anterior margins of segments vi–ix. But this appearance is probably due to the stronger development of a demarcating furrow at the anterior border of the pore tubercle than at the posterior border. When the spermathecal duct is pulled out from the parietes, as may easily be done, the oval area is removed, leaving an aperture with a smooth rim in the body wall that does not belong to one segment more than another. As the pore is at the center of this area it is regarded as intersegmental.

The male apertures are minute, each pore located at the center of a circular or slightly oval (transversely) disk that is clearly marked off from the parietes by a slight furrow. The disks are 2–3 intersetal intervals wide transversely or about 0.5 mm.

There are no genital markings.

Internal anatomy.—Septa 5/6–7/8 are thickly muscular; 8/9 is present and complete though membranous, bulged posteriorly into a funnel-shape by the gizzard, and attached centrally to the esophagus anterior to the hearts of ix; 9/10 lacking; 10/11–13/14 thickly muscular, especially the first three.

The intestine begins in xv. The intestinal caeca are simple, constricted by the septa through which they pass.

The last pair of hearts is in xiii. All hearts of ix–xiii pass into the ventral blood vessel.

The testis sac of xi is horeshoe-shaped (Tatsienlu specimens) on the anterior face of 11/12. The ventral ends of the sac are not in contact beneath the esophagus, and no communication between the ventral ends was found. The hearts of xi are contained within the testis sac and are surrounded by testicular material. A section of the dorsal blood vessel belonging to xi is also contained within the testis sac but is not surrounded by testicular material. The seminal vesicles of xi, small, vertical bodies are not contained within the testis sac but are just lateral to the outer wall of the sac. So far as can be determined from the material available, the testis sac of x is similar to that of xi, and contains the hearts of x. The testis sacs of the Dawei specimen are paired, ovoidal. The anterior sacs project anteriorly

from 10/11 in a diagonal fashion, diverging from each other anteriorly. The sacs are fairly widely separated and are without any apparent connection transversely. The posterior sacs (vesicles of xi excluded) project anteriorly from the base of 11/12 toward 10/11, which is not reached.

The seminal vesicles are small to medium-sized vertical bodies, paired in xi and xii, each vesicle with a dorsal primary ampulla, the primary ampullae of a segment in contact dorsally over the dorsal blood vessel. In segment xiii there is a pair of pseudovesicles, which may be as large as or a trifle smaller than the vesicles of xii. The prostates extend through some or all of segments xvi–xxi. The prostatic duct is 3–5 mm long, bent in a U-shape, the ectal limb much thicker than the ental limb.

The spermathecal duct is not appreciably narrowed in the parietes and is as long as or slightly longer than the ampulla. The diverticulum, which passes into the duct at the parietes or just within the parietes, comprises a long slenderly tubular stalk with an ental, spheroidal, or asymmetrical seminal chamber; the diverticulum longer than the combined lengths of duct and ampulla.

Remarks.—In one of the Tatsienlu specimens there are numerous parasitic bodies in the coelom.

In xiv, of the Dawei specimen, there is a pair of fairly large stalked pseudovesicles. The ovoidal portion at the dorsal end of the stalk is brownish and has a tough, thickish rather than membranous, wall. The brownish material within the vesicles comprises corpuscular bodies, setae, and nematode ova. No nematodes or coelomic Protozoa were found.

Setae as well as nematode ova have been found previously in the pseudovesicles of xiv (see, for instance, Gates, 1932, pp. 479–480).

P. fornicata is distinguished from *P. hongkongensis* Michaelsen, 1910, by the dorsal gap in the setal circle of ii, the absence of genital markings, and the exclusion of the anterior seminal vesicles from the testis sac of xi.

According to Chen (1936, p. 298) *P. fornicata* "is probably identical with *P. pingi* Steph." *P. fornicata* is, on the contrary, clearly distinguished from *P. pingi* by the horseshoe-shaped testis sacs of x and xi. Chen, however, thinks that the testis sacs are "connected ventrally and communicated" rather than as described above. Even if the ventral ends of the "horseshoe-shaped testis sac" are in communication as Chen suspects, the annular testis sac thus formed will still distinguish *fornicata* from *pingi*.

PHERETIMA GRAHAMI Gates

1935. *Pheretima grahami* GATES, Smithsonian Misc. Coll., vol. 93, no. 3, p. 9 (type locality: Da Shiang Lin Pass, Szechwan; types in the U. S. National Museum).

1936. *Pheretima grahami* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 11, p. 298 (after examination of types).

Material examined.—From Dr. Graham: 1 clitellate specimen labeled "Da Shiang Lin Pass, 7,000 feet, August 29, 1928"; 1 clitellate specimen labeled "Ningyuenfu, 7,000 feet, July 1928."

External characteristics.—Length, 235–285 mm. Diameter, 11–15 mm.

The setae begin on ii, on which segment there is a complete circle. There are no definite midventral gaps in the setal circles; middorsal gaps may be present but are of variable width. Setal numbers: vii/22–25, viii/22–27, xvii/10(+?)–26, xviii/10(+?)–19, xix/19 (+?)–25, xx/80–91. (The first number of each pair is from the specimen with the first dorsal pore on 13/14.)

The first dorsal pore is on 12/13 or 13/14.

The clitellum is annular and extends from 13/14 to 16/17; intersegmental furrows and dorsal pores lacking on one specimen, slight vestiges of both on the other specimen. Setae are present, at least midventrally, on xiv–xvi of one specimen; lacking on the other.

The secondary spermathecal pores are widely separated; three pairs, on 6/7–8/9. Each pore is a wide transverse slit; the margin of the slit finely lobulated. On separating the margins of an aperture a deep invagination passing posteriorly (never anteriorly) into vii or viii or ix becomes visible. On the median wall of the invagination there is a finely lobulated ridge. On the roof of the invagination there is a large, oval, genital marking, a portion of which may be visible from the exterior if the margins of the aperture are pulled sufficiently apart. The wall of the spermathecal invagination is extensively and finely wrinkled or furrowed, sometimes with an appearance of cross-hatching.

The apertures of the copulatory chambers are somewhat irregular but approximately transversely slitlike. There is no lateral lip; the body wall just lateral to the aperture thick.

Genital markings are lacking externally.

Internal anatomy.—Septa 5/6–7/8 are thickly muscular; 8/9–9/10, lacking; 10/11–12/13, thickly muscular; 13/14, muscular.

The intestine begins in xv. The intestinal caeca are simple; the dorsal and ventral margins without incisions; or the ventral margin may be incised in such a way as to form 4–6 widely separated, ventrally directed, short fingerlike lobes. On the esophagus just behind the gizzard there is a conspicuous, lobed, reddish, glandular collar.

There is a pair of commissures belonging to ix or a single commissure on the left side. The last pair of hearts is in xiii (2 specimens). All hearts of ix–xiii pass into the ventral blood vessel.

The testis sacs of x and xi are ventral and unpaired. The seminal vesicles of xi and xii are firm vertical bodies filling their segments and in contact transversely above the dorsal blood vessel. In xiii and xiv of one specimen there are paired pseudovesicles, the vesicles of xiv of about the same size as the vesicles of xiii. The prostates extend through xvii–xix. The prostatic duct is about 10 mm long, bent into a C-shape; the ectal two-thirds much thickened. On the floor of xviii on each side and just median to the ectal end of the prostatic duct is a large glandular mass, which can be separated with care into several discrete glands, from each of which a bundle of cords or ducts passes to a genital marking. In each copulatory chamber there are 5 or 6 genital markings; the markings circular to oval, flat-surfaced but protuberant. The minute male pore is on a rather flattened out but still conelike plate or tubercle, which is smaller than the genital markings.

The spermathecal duct is stoutish, shorter than the ampulla, narrowed very abruptly within the parietes just lateral to the glandular mass on the spermathecal chamber. When the duct is pulled out carefully from the parietes a circular area, the surface of which is nearly level with the coelomic face of the body wall, becomes visible. At the center of this area there is a tiny depression from which the narrowed portion of the duct has been removed. The diverticulum, which passes into the median face of the duct close to the parietes comprises a firm, glistening stalk and a longer, thin-walled, seminal chamber. The latter may be looped in a regularly zigzag fashion, the limbs of the loops in apposition. The diverticulum (in the looped condition) is as long as or longer than the combined lengths of the duct and ampulla.

The spermathecal chamber is large, club-shaped, narrowed toward the parietes (i. e., ectally), bent backward and bound to the coelomic floor by connective tissue. This tissue, however, can be cut readily so that the chamber is separated from the ventral parietes. The posterior wall of the chamber (that in contact with the ventral parietes) is thin. On the anterior face of the chamber is a large flattish mass of glandular tissue, oval in outline. From this glandular mass ducts pass to the large, oval, genital marking within the spermathecal chamber. The circular area, with a central depression which becomes visible on removal of a spermatheca, is the dorsal face of a thick tough column of tissue, which passes into the lateral wall of the spermathecal chamber. The narrowed portion of the spermathecal duct is continued through this column to open to the ex-

terior by a minute pore on the tip of a tiny conical protuberance on the lateral margin of the large genital marking in the spermathecal chamber.

Remarks.—One of the specimens is in a much poorer state of preservation than the other. The epidermis is also damaged; the setal counts on the first three postclitellar segments are incomplete. The description of the internal anatomy was derived mainly from the poorer specimen in order to keep the internal organs of the better specimen in good condition for future reference.

In the coelomic cavities of both specimens there are nematodes and spheroidal, cystlike bodies. In one of the worms there are cysts of another sort in the esophageal, postgizzard collar.

P. grahami is distinguished from *P. vulgaris* Chen, 1930, by the ventral, unpaired testis sacs of x and xi, the larger size of the spermathecal chamber, the posterior direction of the chamber, the attachment of the chamber to the ventral parietes, and the single large genital marking within the chamber.

Chen (1936, p. 299) maintains (1) that the "so-called" spermathecal chamber of *grahami* is not homologous with the "parietal invagination of *P. vulgaris*" and (2) that *P. grahami* is a synonym of *P. tschiliensis* Michaelsen 1928:

(1) The remark about homology has no significance. In *P. vulgaris* the spermathecal pore is not in a "parietal invagination" but within a spermathecal chamber (an invagination that extends through the parietes into the coelomic cavity). In fact the term spermathecal chamber was first used in Chen's original description of *vulgaris.* The confusion is due, in part at least, to Chen's failure to discriminate between *vulgaris* (copulatory chambers and U-shaped testis sacs) and *P. guillelmi* (Michaelsen, 1895) (male pore invaginations and ventral testis sacs).

(2) Examination of the types of *tschiliensis* (*vide* description on a subsequent page) has shown that in Michaelsen's species the primary spermathecal pores are superficial. At most the marking that bears the spermathecal pore may be slightly depressed. There is no definite invagination. In *P. grahami*, on the other hand, the primary spermathecal pore is contained within an invagination so large that it not only passes through the parietes into the coelomic cavity but extends posteriorly on the ventral parietes well toward the septum next behind. Such an unusual structure certainly distinguishes *grahami* from any species with superficial spermathecal pores. The copulatory chambers further distinguish *grahami* from *tschiliensis* or any other species with male pores in invaginations restricted to the parietes.

PHERETIMA GUILLELMI (Michaelsen)

1895. *Perichaeta guillelmi* MICHAELSEN, Abh. Nat. Ver. Hamburg, vol. 13, no. 2, p. 32, (type locality: Shi-hui-yao near Wuchang, Hupei; types in the Hamburg Museum).

1925. *Pheretima houlleti* STEPHENSON, Proc. Zool. Soc. London, 1925, p. 890 (Nanking; specimens in the British Museum).

1930. *Pheretima vulgaris agricola* CHEN, Sci. Rep. Nat. Cent. Univ. Nanking, ser. B, vol. 1, p. 18 (part only ?) (type locality: Nanking ?; types ?).

1931. *Peretima houlleti* MICHAELSEN, Lingnan Sci. Journ., vol. 8, p. 159 (part only ?) (excluding *houlleti* Michaelsen, 1899 ?).

1931. *Pheretima* (*Ph.*) *houlleti* MICHAELSEN (part only ?) (excluding *houlleti* Michaelsen, 1899 ?)+*P. guillelmi* Michaelsen, Peking Nat. Hist. Bull., vol. 5, pt. 3, pp. 2, 13.

1932. *Pheretima guillelmi* GATES, Lingnan Sci. Journ., vol. 11, p. 511.

1933. *Pheretima guillelmi* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 9, p. 249 (part) (excluding *P. vulgaris* in part, forms with copulatory chambers).

1933. *Pheretima ichangensis* FANG, Sinensia, vol. 7, p. 180 (type locality: Ichang, Hupei; types in the Metropolitan Museum of China).

1935. *Pheretima guillelmi* GATES, Smithsonian Misc. Coll., vol. 93, no. 3, p. 10.

THE FOLLOWING PLACED DOUBTFULLY IN SYNONYMY:

1899. *Amyntas houlleti* MICHAELSEN, Mitt. Naturhist. Mus. Hamburg, vol. 16, p. 12.

1936. *Pheretima guillelmi* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 11, p. 270 (Szechwan).

Material examined.—From the Hamburg Museum: 6 specimens labeled "*Pheretima* (*Ph.*) *guillelmi* Mich. W. Lohr 1. d. China. Prov. Hupei. Original Stucke." From the British Museum: 4 clitellate specimens labeled "*P. Houlleti.*" From the Metropolitan Museum of China: 2 dissected clitellate specimens labeled "*P. ichangensis* Fang. Ichang. Hupeh. 1929." From the U. S. National Museum: 2 aclitellate and 15 clitellate specimens labeled "Kiangsu-Nanking. National Southeastern University by C. Ping."

External characteristics.—Length, 96–150 mm. Diameter, 5–8 mm.

The setae begin on ii, on which segment there is a complete circle. Setae of the preclitellar segments are enlarged, especially ventrally, the size decreasing posteriorly; regularly spaced. Middorsal and midventral gaps may be entirely lacking in the setal circles; the middorsal gaps, when present, variable in width; a midventral break, when present, very slight. The setal numbers are as follows:

vii	viii	xvii	xviii	xix	xx	Locality
12	13	14	14	18	54	Hupei.
15	16	18	17	18	56	(1).
------	--------	20	19	19	--------	(1).
15	16	15	15	17	59	
18	19	17	15	17	55	
------	--------	18	15	17	60	
17	17	18	16	17	--------	Nanking.
17	17	20	19	18	--------	
18	19	21	16	19	--------	
16	17	20	15	18	61	
17	18	19	14	16	55	
19	21	21	15	21	--------	
16	16	17	13	16	--------	
16	17	18	18	20	57	(1).
21	22	22	21	22	--------	(1).
16	18	20	20	21	64	
13	13	--------	15	--------	54	
12	14	16	15	16	60	
14	18	18	14	16	[2] 44	
16	16	17	19	19	--------	Ichang.
15	16	18	15	18	--------	
19	21	20	18	20	54	Nanking (Brit. Mus.).
17	18	18	15	20	53	
15	18	17	17	20	59	

[1] Aclitellate.
[2] Several gaps in which setal pits are visible but apparently no setae in the pits.

The first dorsal pore is on 12/13 (29 specimens).

The clitellum is annular, extending from 13/14 to 16/17; setae lacking on fully clitellate specimens, present ventrally on one partially clitellate specimen. Functional dorsal pores or nonfunctional porelike markings and slight indications of intersegmental furrows are visible on several specimens on which the clitellar glandularity may not have reached full development. There are functional dorsal pores on 13/14 and 16/17.

The secondary spermathecal pores are transverse slits opening into deep pits, 3 pairs, on 6/7–8/9.

The apertures of the male pore invaginations are crescentic, the concave side facing midventrally. In many of the rather soft Nanking specimens the apertures gape open, disclosing more or less of the median wall of the invagination. The invaginations are rather shallow. The lateral lip or wall is thin and lacks setae. The median wall of the invagination is firmer than the lateral wall and is ridged, the ridge in line with the male setae and cut up, as a rule, by short furrows into fine lobes. On these lobes or between the lobes there are setae, usually 2–3 in each invagination, which have been included in the male setae in the preceding table. The setae are 0.49–0.61 mm long, straight or slightly sigmoid, with a slight bend of the ental ends, the ectal tips narrowing gradually to a bluntly

rounded end and ornamented with short transverse rows of very fine teeth.

The tips of about a quarter of the setae examined are very shortly bifid. On all except one of the fully clitellate specimens there is, on each side, a short gap in the setal circle just median to the aperture of the invagination. The setae within the invagination are thus slightly isolated from the other male setae. Just lateral to the lobulated ridge and in the dorsalmost portion of the invagination is a single, bluntly rounded, rather mammalike smooth and glistening tubercle. On the ventral face of the tubercle is the minute male pore. In one of the Hamburg specimens each male pore is on a transversely oval, flat area. There are no definite genital markings or papillae within the invagination aside from the male pore tubercle. The lobulations of the median ridge sometimes look much like genital markings or tubercles, especially in one worm where one of the lobulations in each invagination has been crowded anteriorly into a position just in front of the main portion of the ridge. No pores have been found on these lobulations or demarcation into rims and central areas as on genital markings associated with glands.

The only genital markings are tiny circular tubercles in close proximity to the spermathecal apertures, usually but one of these markings associated with each aperture, rarely two. The marking is on the anteriormost margin of the segment just at or actually within the secondary spermathecal aperture. The marking sometimes appears to be just median to the aperture. Perhaps a more complete retraction of the spermathecal chamber would result in retracting the marking into the parietes. When two markings are visible in connection with any spermathecal pore, one is always within the aperture. In one specimen the marking in connection with each spermathecal aperture is on the posteriormost margin of the segment and immediately in front of the aperture.

Internal anatomy.—Septa 5/6–7/8 are thickly muscular; 8/9–9/10 lacking; 10/11–12/13 thickly muscular; 13/14 muscular; 14/15 slightly muscular.

The intestine begins in xv (18 specimens). The intestinal caeca are simple but the ventral margins, especially posteriorly, are slightly incised in such a way as to produce an appearance of a row of very short but definite lobulations. There is a small, whitish, occasionally lobed, glandular collar on the esophagus just behind the gizzard.

The single heart of ix is on the right side in 8 specimens, on the left side in 6 specimens. The hearts of x are present in all specimens but are often concealed by the connective tissue that binds

them to the anterior face of 10/11. The last pair of hearts is in xiii (18 specimens). All hearts of ix–xiii pass into the ventral vessel.

The testis sacs of x and xi are ventral and unpaired. The seminal vesicles of xi and xii fill their segments and reach into contact transversely above the dorsal vessel. Each vesicle is provided with a primary ampulla, which may be constricted off by a circumferential furrow from the ventral lamina or the base of the primary ampulla may be narrowed or flattened and sunk into the dorsal margin of the ventral lamina. The primary ampulla may reach a length equal to one third of that of the entire vesicle.

The prostates extend through xvi or xvii to xix, xx, or xxi. The prostatic ducts are 6–10 mm long, each duct usually bent into a hairpin-shape, with the ectal limb much thicker than the ental limb. In a few specimens the loop is more open so that the duct has a C-shape. The thick portion of the duct at first appears to pass directly into the parietes, but if connective tissue around the duct near the parietes is carefully dissected off a much slenderer portion, bent into one or two tiny, very short U-shaped quirks, becomes visible.

No stalked glands or glandular masses can be found on the parietes or within the parietes in the vicinity of the prostatic ducts.

The spermathecal duct is smooth, the coelomic portion of about the same diameter throughout and about equal in length to the ampulla. The diverticulum passes into the anterior face of the duct close to the parietes; ectal to this junction the duct is much narrowed. The diverticular stalk is slender, smooth, and firm, about equal in length to the coelomic portion of the spermathecal duct or slightly shorter, always shorter than the seminal chamber. The latter is wider than the stalk, thin-walled and zigzag looped, apparently within a delicate, transparent, connective tissue sac or investment. The limbs of the loops are very short and in contact. Usually all except two or three of the loops are in the same plane. In one specimen all seminal chambers are straight and without any trace of looping or constriction.

If the spermathecal duct is grasped firmly at its junction with the diverticulum and carefully and slowly pulled out from the parietes, a small circular patch of tissue becomes visible which projects slightly into the coelomic cavity. At the center of this patch is a tiny concave depression from which the narrowed portion of the spermathecal duct has been removed. The circular patch of tissue is the thin dorsal wall of a spermathecal chamber, which is almost entirely confined to the parietes. Within the spermathecal chamber are the genital markings or tubercles (one or rarely two)

and a tiny protuberance on which the minute, primarily spermathecal pore is located. This protuberance does not appear to be definitely demarcated as are the genital markings. Closely associated with each spermathecal chamber are one or two stalked glands. The stalk of the median gland passes into the parietes at the side of the spermathecal chamber and to the genital marking visible externally just at the mouth of the chamber. The stalk of the posterior gland passes into the posterior wall of the chamber and to the genital marking that is deepest within the chamber. A third gland when present may be lateral or anterior to the spermathecal chamber. If only one gland is present it is always posterior. The stalks of the glands may be short and practically confined to the body wall or much longer and with a definitely coelomic portion. The junction of the spermathecal duct and the dorsal face of the spermathecal chamber is covered over with connective tissue and unless this tissue is dissected off the duct has the appearance of passing into the parietes undiminished in diameter.

(NOTE: As the spermathecal pore invagination appears to pass through the parietes into the coelomic cavity the invagination is called a spermathecal chamber, but the chamber is small, especially in comparison with that of *P. grahami.*)

Remarks.—The Hamburg specimens are very stiff and brittle, the body wall so transparent that recognition of the external characteristics is difficult. The brittleness was overcome by a short period of soaking in water, but prolongation of the soaking results in a gelatinization of the organs.

On the smallest aclitellate specimen the male pore areas are small, transversely oval patches in the setal circle, which are not clearly demarcated from the neighboring portion of the ventral surface. The male pores, however, can be recognized at the centers of these areas. On a slightly larger specimen the margin of each male pore area is clearly demarcated, except mesially, by a crescentic or U-shaped furrow, the concave side of the crescent or of the U facing midventrally. The deepening of this furrow produces the parietal invagination which is also crescentic to U-shaped in section. The sites of the spermathecal apertures on the aclitellate specimens are represented by tiny, almost minute, depressions on the intersegmental furrows.

One of the U. S. National Museum specimens is abnormal, having a prostate, duct, and male pore invagination in segment xix rather than xviii on the left side.

In one of the Hamburg specimens there are a number of coelomic nematodes. In four of the U. S. National Museum specimens there are numbers of gregarinoid Protozoa in the coelomic cavities through-

out the postclitellar segments. In one of these worms there are on the ducts of two of the spermathecae a number of vesicular outgrowths similar to those recorded by Michaelsen and Stephenson from *P. pingi.*

The British Museum specimens are not labeled, except for the notation "*P. houlleti*" on the invoice, but they were forwarded by Dr. C. C. A. Monro, of the British Museum, in reply to a request for Stephenson's specimens of *P. houlleti* from Nanking. The worms are characterized by the presence of setae in the male pore invaginations and by the posterior location of the spermathecal stalked glands but differ from other specimens of *P. guillelmi* in the presence of glandular material on the parietes just median to the ectal ends of the prostatic ducts. No definite genital markings were noted in the male pore invaginations. The first functional dorsal pore is on 12/13 on each of the four specimens, but on 2 specimens there is a porelike marking on 11/12.

The specimens of *P. ichangensis* have been compared side by side with Stephenson's specimens of *P. houlleti* (=*P. guillelmi*) and with the specimens of *P. guillelmi.* The only difference that was found was the presence in both specimens of *P. ichangensis*, in xviii median to the prostatic duct, of a stalked gland opening to the exterior by a pore on a rather indefinite genital marking in the male pore invagination. Retention of *P. ichangensis* on the basis of such an unimportant characteristic can scarcely be justified.

Michaelsen's 1899 specimens of *Amyntas houlleti* appear to have been lost; at least they are not in the Hamburg Museum. The Tientsin record is based on a simple "Fundnotiz" without description. It is accordingly impossible to determine what species Michaelsen actually had, but in the absence of any valid record of the occurrence of *P. houlleti* in north China and in view of the confusion of *P. guillelmi* with *P. houlleti* it seems possible that the Tientsin specimens were *P. guillelmi.*

P. guillemi is distinguished from *P. houlleti* with which it has been confused by the restriction of the male pore invaginations to the parietes, the conformation of the male porophore, and the presence of setae within the male pore invagination.

PHERETIMA HAWAYANA (Rosa)

1891. *Perichaeta hawayana* Rosa, Ann. Nat. Hofmus. Wien, vol. 6, p. 396 (type locality: Hawaii; type in the Vienna Museum).

1896. *Perichaeta hawayana* Beddard, Proc. Zool. Soc. London, 1896, p. 201 (Hongkong).

1912. *Pheretima hawayana* Stephenson, Rec. Indian Mus., vol. 7, p. 276 (Tengyueh, Yunnan).

1931. *Pheretima* (*Ph.*) *hawayana* MICHAELSEN, Lingnan Sci. Journ., vol. 8, p. 159 (part) (excluding quadrithecal forms); Zool. Jahrb. (Abt. Syst.), vol. 61, p. 574 (Hongkong and Canton; Berlin Museum); Peking Nat. Hist. Bull., vol. 5, pt. 3, p. 3 (part) (excluding quadrithecal forms).

1931. *Pheretima* (*Ph.*) *hawayana* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 7, p. 142 (part) (excluding synonymy of quadrithecal forms; Szechwan).

1932. *Pheretima hawayana* GATES, Lingnan Sci. Journ., vol. 11, p. 512 (part) (excluding quadrithecal forms).

1933. *Pheretima hawayana* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 9, p. 238 (Chekiang).

1935. *Pheretima hawayana* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 11, p. 121 (Amoy); Bull. Fan Inst. Biol. Peiping, vol. 6, p. 33 (Hongkong).

THE FOLLOWING PLACED DOUBTFULLY IN SYNONYMY:

1910. *Pheretima hawayana* var. *barbadensis* MICHAELSEN, Mitt. Naturhist. Mus. Hamburg, vol. 27, p. 102 (Foochow).

1927. *Pheretima hawayana* MICHAELSEN, Boll. Lab. Zool. Portici, vol. 21, p. 84 (Yunnan). (According to Michaelsen the setae are enlarged on iv–viii, which may perhaps be regarded as an indication that the worm actually is *hawayana*, but the number of spermathecae is not mentioned.)

Material examined.—From the British Museum: 3 specimens from a tube[2] labeled "*P. barbadensis* 1904.10.5.1219.1228. Hongkong coll. Beddard" (an additional label inside the tube is as follows: "*Pheretima barbadensis* and varieties?"); 4 specimens from a tube labeled "*P. morrisi* 1904–10.5.453. Hongkong coll. Beddard"; and 2 specimens labeled "*Pheretima hawayana* forma *typica*. (1925.55.12.12/13. *Tengyueh*, Yunnan. Indian Museum." From Dr. Graham: 1 specimen labeled "Suifu, April 1923"; 1 specimen labeled "Suifu, 1,000-1,500 feet, May 21–26, 1930"; 1 specimen labeled "South of Suifu, 1,200 feet, May 11, 1924"; 1 specimen labeled "Suifu, June 1924"; 1 specimen labeled "Between Suifu and Kiating, 1,000–1,400 feet, June 26–July 3, 1930."

PHERETIMA HONGKONGENSIS Michaelsen

1910. *Pheretima hongkongensis* MICHAELSEN, Mitt. Naturhist. Mus. Hamburg, vol. 27, p. 107 (type locality: Hongkong; type in the Hamburg Museum).

1931. *Pheretima* (*Ph.*) *hongkongensis* MICHAELSEN, Lingnan Sci. Journ., vol 8, p. 159; Peking Nat. Hist. Bull., vol. 5, pt. 3, p. 2.

1935. *Pheretima hongkongensis* GATES, Smithsonian Misc. Coll., vol. 93, no. 3, p. 10.

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[2] The first tube from the British Museum contains specimens of *P. hawayana*, *P. morrisi*, *P. diffringens*, and a species of *Pheretima* with spermathecal pores on 7/8–8/9. The second tube contains specimens of *P. hawayana*, *P. morrisi*, and a species of *Pheretima* with spermathecal pores on 7/8–8/9. A third tube labeled "*Pheretima barbadensis* 1914.10.5.1347.54. Calcutta coll. Beddard" contains specimens of *P. morrisi*, *P. houlleti*, and *P. posthuma*.

Material examined.—From the Hamburg Museum: 1 clitellate specimen in good condition labeled "V 9084. *Pheretima hongkongensis* Mich. Cohn. Hongkong."

External characteristics.—The setae are small, closely and regularly spaced; they begin on ii, on which segment there is a complete circle. Setal formula: vi/21, vii/20, viii/8+, xvii/17, xviii/7, xix/15, xx/58+? (xiv/4, xv/2, xvi/7). The body wall has been ruptured or abraded midventrally at several places, among which is included segment xx. There are gaps ventrally in the setal circle of viii, possibly due to the falling out of setae.

The clitellum is annular, extending from 13/14 to 16/17; dorsal pores and intersegmental furrows lacking or not clearly indicated; setae present ventrally. The clitellum is dull and roughish, not smooth and glistening, apparently not fully developed.

The first dorsal pore is on 11/12.

The spermathecal pores are minute, transverse slits, four pairs, each pore at the center of a very small, smooth, transversely oval area.

The male pores are minute, each pore a trifle lateral to the center of a male pore marking. The latter is nearly but not quite circular in shape, 1½–2 intersetal intervals wide transversely, slightly protuberant but with a rather flat surface and surrounded by a slight but definite circumferential furrow. Just median to each male pore marking is a single transversely oval genital marking with a conspicuously protuberant, whitish rim and a depressed, grayish, central area; 2–3 intersetal intervals wide transversely. The genital marking is not in actual contact with the male pore area though close to it.

Internal anatomy.—Septum 8/9 is present at least as a ventral rudiment.

The intestinal caeca are simple, without marginal incisions or septal constrictions. The typhlosole projects conspicuously into the gut lumen as a bladelike ridge beginning with the first postcaecal segment. On the ventral face of the typhlosole is a large blood vessel distended with blood.

The last pair of hearts is in xiii. There are masses of nephridia in v and vi and large lymph glands in the intestinal segments.

The testis sac of x is unpaired and ventral. The testis-sac of xi is U-shaped, the limbs of the U reaching to the dorsal blood vessel. The seminal vesicles of xi are within the testis sac of xi, surrounded by a thin layer of testicular coagulum. There is only a small quantity of testicular coagulum in the testis sac of x.

The seminal vesicles are medium-sized vertical bodies, each with a deep dorsoventral groove on the posterior face. Each vesicle is

provided with an elongate, more or less fingerlike, primary ampulla, the base of which is sunk deeply into a cleft in the dorsal margin.

The prostate ducts are 6–8 mm in length, muscular, but uniformly slender throughout, i. e., without special thickening of an ectal portion.

The spermathecae are flattened out on the ventral parietes. The duct is much shorter than the ampulla, almost triangular in outline. The diverticulum, which passes into the anterior face of the duct just at or within the parietes, is a slender, elongate-tubular structure. In an ectal stalk portion of the diverticulum (about one-half or more of the length) the lumen is narrow; the wall of the lumen smooth or ridged transversely. In the remaining ental portion of the diverticulum the lumen gradually widens until the wall becomes very thin. This ental portion is doubtless the seminal chamber, but it is not noticeably wider than the stalk nor marked off from the stalk. Within the seminal chamber is an elongate, opaque, firm mass with no spermathecal iridescence, the mass composed of corpuscular bodies and smaller, homogeneous, spheroidal to ovoidal particles. Several bodies, apparently nucleated, that may be parasites were also noted.

Dorsal to each genital marking a glandular mass projects through the parietes and very slightly into the coelomic cavity, the glandular material just median to the ectal end of the prostatic duct.

Remarks.—Michaelsen (1910, p. 107) referred to the holotype as "ein vollständiges geschlechtsreife Exemplar." The clitellar glandularity is almost certainly not fully developed and this together with the small quantities of testicular coagulum in the testis sacs indicates that the worm is either not quite normal (also note spermathecae) or not completely sexual (presexual or postsexual).

Although the gut, septa, and attached organs of the anterior segments had been dissected from the worm, dissection and preservation were such that determination of the characteristics of the testis sacs was not difficult.

PHERETIMA HUPEIENSIS (Michaelsen)

1895. *Perichaeta hupeiënsis* MICHAELSEN, Abh. Naturw. Verein Hamburg, vol. 13, no. 2, p. 35 (type locality: Shi-hui-yao near Wuchang, Hupei; types in the Hamburg Museum).

1899. *Amyntas hupeiensis* MICHAELSEN, Mitt. Naturhist. Mus. Hamburg, vol. 16, p. 6 (previous misstatement as to number of spermathecae corrected).

1910. *Pheretima hupeiensis* MICHAELSEN, Mitt. Naturhist. Mus. Hamburg, vol. 27, p. 102 (Foochow).

1931. *Pheretima* (*Ph.*) *hupeiensis* MICHAELSEN, Lingnan Sci. Journ., vol. 8, p. 159; Peking Nat. Hist. Bull., vol. 5, pt. 3, p. 3.

1931. *Pheretima* (*Ph.*) *hupeiensis* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 7, p. 122 (Szechwan).
1933. *Pheretima hupeiensis* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 9, p. 251 (Kiangsu, Chekiang, Anhwei, Kiangsi).
1935. *Pheretima hupeiensis* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 11, p. 121 (Amoy).
1935. *Pheretima hupeiensis* GATES, Smithsonian Misc. Coll., vol. 93, no. 3, p. 11.
1936. *Pheretima hupeiensis* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 11, p. 271 (Szechwan).

Material examined.—From the Hamburg Museum: 1 clitellate specimen labeled "V 9086. *Pheretima hupeiensis* Mich. Cohn. Futschau."

External characteristics.—The setae begin on ii, on which segment there is a complete setal circle. The setae are small and closely crowded both dorsally and ventrally, and the circles are without definite middorsal or midventral breaks. Setal formula: vii/15, viii/19, xviii/18, xx/*ca.*85. There is a row of setae ventrally on each of the clitellar segments; xiv–10, xv–9, xvi–14, the row on xiv with a midventral break just behind the female pore.

The first dorsal pore is on 11/12.

The clitellum is annular, extending from 13/14 to 16/17; intersegmental furrows and dorsal pores lacking.

The spermathecal pores are minute, segmental in position, on the anteriormost margins of vii, viii, and ix; each pore on a very small, slightly protuberant, rounded knob.

The male pores are superficial, each pore at the center of a small, nearly circular, grayish area, the pore itself in a slight transverse depression. The male pore areas are located in the setal circle of xviii and are not very sharply marked off from the neighboring portions of the body wall.

The genital markings are two pairs, on 17/18 and 18/19, the intersegmental furrows ending abruptly against the bases of the markings. Each marking is slightly elevated, flattened, with a grayish translucent appearance, the rim slightly more opaque than the center. The center of a genital marking is very slightly median to the center of the male pore area. The markings are transversely oval to almost circular and about 3–5 intersetal intervals wide transversely.

Internal anatomy.—All septa from 5/6–13/14 are present and more or less thickly muscular.

The intestinal caeca are simple, both dorsal and ventral margins smooth. The intestine begins in xv. There is a small but definitely lobed, glandular collar on the esophagus in ix, just behind 8/9.

Both hearts of ix are present. The last pair of hearts is in xiii. All hearts of ix–xiii pass into the ventral vessel.

The testis sac of x is **U**-shaped; the limbs of the **U** passing dorsally at the sides of the esophagus contain the hearts of x. The testis sac of xi is also **U**-shaped and the limbs of the **U** contain in addition to the hearts of xi the seminal vesicles of that segment. The prostatic ducts are **C**- or **S**-shaped.

The last two pairs of spermathecae are in viii, one pair opening to the exterior posteriorly. The spermathecal duct is shorter than the ampulla, the coelomic portion stoutish and rather definitely marked off from the ampulla. The parietal portion of the duct is much narrower than the coelomic portion. The diverticulum passes into the duct in the parietes. When the spermatheca is pulled out from the parietes the ectal ends of the duct and diverticulum are surrounded by soft whitish tissue, which can be easily dissected off. The diverticulum is much longer than the combined lengths of the duct and ampulla and comprises a short, firm, glistening, slenderly tubular stalk, which is a trifle longer than the duct and a much longer and wider seminal chamber with a thin, wrinkled wall.

There is softish glandular material in the parietes dorsal to each of the genital markings, but this material does not project conspicuously into the coelomic cavity and is not visible until after the removal of connective tissue.

Remarks.—The original material has not been examined.

In the original description the spermathecal pores were said to be two pairs on 7/8–8/9. In the 1899 paper, after reexamination of the original material this was corrected to three pairs on 6/7–8/9.

According to Chen (1931) the spermathecal pores are on the intersegmental furrows, but behind each pore and on the anterior margin of the segment is a "bun-shaped papilla." If Chen's specimens are like the Hamburg worm the spermathecal pore is in reality on the papilla. Chen found "about 10" setae on viii between the spermathecal pore lines.

PHERETIMA IGNOBILIS Gates

1935. *Pheretima ignobilis* GATES, Smithsonian Misc. Coll., vol. 93, no. 3, p. 11 (type locality: Ningyuenfu, Szechwan; type in the U. S. National Museum).

1936. *Pheretima ignobilis* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 11, p. 299 (after examination of type).

Material examined.—From Dr. Graham: 1 aclitellate specimen labeled "Near Ningyuenfu, 7,000 feet, July 28, 1928."

External characteristics.—Length, 55 mm. Diameter, 3 mm.

The setae begin on ii, on which segment there is a complete circle. Setal formula: vi/17, vii/16, viii/16, xvii/15, xviii/9, xix/16.

The first dorsal pore is on 11/12.

The secondary spermathecal apertures are transverse slits, four pairs, on 5/6–8/9.

In the setal circle of xviii on each side there is a transversely slitlike depression. The margin of the slit is smooth and glistening. External to the smooth circumferential lip there are several concentric circumferential furrows. The male pores are tiny slits, each pore on the roof of the depression and close to the median margin.

There are no genital markings.

Internal anatomy.—Septa 8/9–9/10 are lacking.

The intestine begins in xv. The intestinal caeca are simple, but from the ventral margin of the caecum there protrude ventrally several short, stumpy, fingerlike lobes, the dorsoventral length of these lobes is less than the dorsoventral diameter of the main portion of the caecum.

There is a single heart belonging to ix, on the left side. The last pair of hearts is in xiii. All hearts of ix-xiii pass into the ventral blood vessel.

On the anterior face of 10/11 is a pair of conical, anteriorly directed, ventral testis sacs, the sacs not in contact but not widely separated. There is also a pair of ventral testis sacs in xi. The seminal vesicles are vertical bodies, each with a primary ampulla reaching to the dorsal blood vessel. In segment xiii is a pair of relatively large pseudovesicles. The prostates extend through xvii–xix. The prostatic duct is short, bent into a **C**-shape, the ectal portion thicker than the ental portion.

The spermathecae are juvenile. The coelomic portion of the duct is of about the same thickness as the ampulla and of about the same length, but within the parietes the duct becomes thicker and its lumen wider. The diverticulum, which passes into the anterior face of the duct in the parietes and which is as long as or slightly longer than the duct and ampulla together, is slenderly tubular with just a slight suggestion of a spheroidal widening of the ental end.

Remarks.—No parasites were found. The worm appears to be normal.

P. ignobilis cannot be adequately characterized at present. It is, however, distinguished from all octothecal Chinese species of *Pheretima* by the presence of spermathecal pore (parietal only?) invaginations, with large, transversely slitlike, secondary, apertures.

PHERETIMA LIMELLA Gates

1935. *Pheretima limella* GATES, Smithsonian Misc. Coll., vol. 93, no. 3, p. 11 (type locality: Suifu, Szechwan; types in the U. S. National Museum).

1936. *Pheretima limella* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 11, pp. 272, 299 (Szechwan; after examination of type).

Material examined.—From Dr. Graham: 1 clitellate specimen labeled "Suifu, 1922"; 1 aclitellate specimen labeled "Suifu, December 7–10."

External characteristics.—Length, 60–85 mm; the longer of the two specimens is incomplete posteriorly. Diameter, 2½–5 mm.

The setae begin on ii, on which segment there is a complete circle. The setae are small, closely crowded, and difficult to count; the setal circles unbroken either at the midventral or middorsal lines. The setal numbers are as follows, the first of the two specimens being the clitellate:

v	vi	xvii	xviii	xix
38	----------	18	14	18
----------	51	29	21	26

The first dorsal pore is on 12/13 (2 specimens).

The smaller specimen is apparently fully clitellate, the clitellum annular, extending from 13/14 to the setae of xvi. Intersegmental furrows and dorsal pores are lacking; setae present on xvi at least ventrally, a few scattered setae on xiv and xv. There is no trace of clitellar glandularity on the larger specimen.

The spermathecal pores are minute, widely separated, one pair, on 5/6, on tiny tubercles.

The male pores are minute, each at the center of a small, oval, convex, smooth-surfaced tubercle. On the tubercles of the clitellate specimen there is a slight transverse central furrow. At the lateral margin of each tubercle is a thin fold of tissue that can be drawn mesially over the tubercle like an eyelid.

The genital markings are paired, on xvii, presetal, extending from the setae to 16/17, each marking elongate-oval to almost circular, slightly elevated, with smooth, flat surface, about 6–8 intersetal intervals wide, separated from the other marking by a midventral distance equal to 10–12 intersetal intervals. On the clitellate specimen there is an additional asymmetrical marking, presetal, on the right side of xvi.

Internal anatomy.—Septa 6/7–9/10 are all present and thickly muscular; 10/11–13/14 are strengthened but membranous.

The gizzard is in viii. There is a slight but lobed glandular collar on the esophagus in ix just behind 8/9. The intestine begins in xvi. The intestinal caeca are simple, long; the dorsal and ventral margins smooth.

In segment ix there is a pair of large, heartlike, blood-filled commissures, passing ventrally from the supraesophageals. In the same

segment there is also a heartlike commissure passing from the dorsal blood vessel to the ventral vessel. The commissures of x pass from the supraesophageals to the ventral trunk. In viii there is a pair of large vessels passing from the dorsal trunk to the gizzard, but no commissures to the ventral vessel were found. The last pair of hearts is in xiii.

The testis sacs of x and xi are unpaired and ventral. The seminal vesicles are small and lateral in position. The prostates are confined to xviii. The prostatic duct is about 2½ mm in length, bent into a sort of C-shape, the ectal half thicker than the ental half.

The spermathecae are large relative to the size of the worm in the clitellate specimen, obviously but partially developed in the aclitellate worm. The duct is long and slender, longer than the ampulla. The diverticulum is longer than the combined lengths of duct and ampulla and passes into the duct close to the parietes. The diverticulum comprises three regions: a slender, smooth, ectal portion, which has a very narrow lumen; a shorter but slightly wider middle portion that is bent into 2–3 very short loops and in which the lumen is slightly widened; and an ental, ovoidal, thin-walled, seminal chamber.

In the parietes dorsal to each genital marking is a whitish mass, that does not project into the coelomic cavity.

Remarks.—Neither of the specimens is in good condition; the aclitellate specimen is softened; the clitellate specimen very brittle—in spite of considerable care the worm broke into two pieces, the break slightly in front of the clitellar region.

Chen (1936, p. 273) places the gizzard in ix (presumably a typographical error) and the male pore (p. 272) *lateral* to the tubercle in the male pore invagination.

P. limella is distinguished from *P. zoysiae* Chen, 1933, by the presence and muscularity of septa 8/9–9/10 and by the presence of genital markings.

PHERETIMA MORRISI (Beddard)

1892. *Perichaeta morrisi* Beddard, Proc. Zool. Soc. London, 1892, p. 166 (type locality: Penang; type in the British Museum).

1896. *Perichaeta insulae* Beddard, Proc. Zool. Soc. London, 1896, p. 204 (type locality: Hongkong; type in the British Museum).

1912. *Pheretima browni* Stephenson, Rec. Indian Mus., vol. 7, p. 273 (part) (excluding quadrithecal forms with spermathecal pores on 7/8–8/9; Tengyueh, Yunnan).

1931. *Pheretima (Ph.) hawayana* Michaelsen, Lingnan Sci. Journ., vol. 8, p. 159 (part) (excluding sexthecal forms); Peking Nat. Hist. Bull., vol. 5, pt. 3, p. 3 (part) (excluding sexthecal forms).

1931. *Pheretima (Ph.) morrisi* Chen, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 7, p. 148 (Szechwan).

1932. *Pheretima hawayana* GATES, Lingnan Sci. Journ., vol. 11, p. 512 (part) (excluding sexthecal forms).

1932. *Pheretima hawayana barbadensis* UDE, Archiv für Naturg., new ser., vol. 1, p. 155 (Foochow).

1933. *Pheretima morrisi* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 9, p. 267 (part) (excluding *P. browni* Gates, 1932, from the synonymy—there is no such reference; Chekiang).

1935. *Pheretima morrisi* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 11, p. 121 (Amoy); Bull. Fan Inst. Biol. Peiping, vol. 6, p. 33 (Hongkong).

1936. *Pheretima morrisi* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 11, p. 270 (Szechwan).

Material examined.—From the British Museum: 1 dissected clitellate specimen labeled "*Pheretima insulae.* 1904.10.5.86. Hongkong. Coll. Beddard"; 31 specimens from a tube labeled "*Pheretima barbadensis.* 1904.10.5.1219.1228. Hongkong. Coll. Beddard"; 3 specimens from a tube labeled "*Pheretima morrisi.* 1904.10.5.453. Hongkong. Coll. Beddard." From Dr. Graham: 1 clitellate specimen labeled "Suifu, 1,000–1,500 feet"; 2 clitellate specimens labeled "Near Yueh Shi, 6,000–8,000 feet, August 11, 1928"; 1 clitellate specimen labeled "Mupin, 3,500–5,000 feet, July 1, 1929"; 2 clitellate specimens labeled "South of Suifu, 1,200 feet, May 11, 1924"; 9 clitellate specimens labeled "At Lo-gu in the Ning-Yuen-fu prefecture, 6,500–8,000 feet, July 22–23, 1928"; 8 specimens labeled "Uingin-shien, 2,500–7,000 feet, July 14–15, 1928."

Remarks.—The first dorsal pore (Szechwan specimens only) is on 10/11 or 11/12 (but with a definitely porelike though apparently nonfunctional marking on 10/11).

The setal numbers and location of genital markings of 10 of the Szechwan specimens are as follows:

vi	xvii	xviii	xix	Preclitellar [1]		Postclitellar genital markings [2]
				Median genital markings	Lateral genital markings	
22	17	10	18	vi, vii	vii	xviii
25	17	14	21	vii, viii	vii	xviii–xix
23	23	13	20	vi, vii, viii	0	0
24	26	17	19	vii, viii	0	0
22	21	14	19	vi, vii	0	0
24	20	15	19	0	vii	0
23	18	15	19	0	vii	0
25	19	13	20	vii	0	0
21	19	15	18	vii	vii	0
24	19	15	21	0	0	0

[1] Median markings are unpaired, lateral markings are paired, all presetal.
[2] Excluding the usual pair of markings just median to the male pore tubercle.

PHERETIMA OMEIMONTIS Chen

1931. *Pheretima* (*Ph.*) *paraglandularis* var. *omeimontis* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 7, p. 155 (type locality: Mount Omei, Szechwan; types in the Museum of the Science Society of China).

1935. *Pheretima omeimontis* GATES, Smithsonian Misc. Coll., vol. 93, no. 3, p. 12.

Material examined.—From Dr. Graham: 1 clitellate specimen labeled "Suifu, September 1924."

External characteristics.—Length, 91 mm. Greatest diameter, 4 mm. The setae begin on ii, on which segment there is a complete circle. The setae are small, fairly closely crowded and regularly spaced. Setal formula: viii/23, xvii/17, xviii/12, xix/16.

The first dorsal pore is on 12/13.

The clitellum is annular, extending from 13/14 to 16/17; intersegmental furrows, dorsal pores, and setae lacking.

The spermathecal pores are minute, two pairs on 7/8–8/9, on tiny tubercles.

The male pores are minute, each pore at the center of a tiny tubercle, which in turn is at the center of a clearly marked, transversely oval area. After the prostatic duct was carefully pulled out from the parietes, the tubercle was removed, with a round aperture left at the center of the oval area.

The genital markings are small, circular, grayish, pore-bearing disks, on segments xi and xviii. The preclitellar markings are restricted to the anterior portion of the segment, arranged into a rectangular patch that is about 12 intersetal intervals wide transversely and that reaches from the setae to 10/11. There are 42 markings on the patch, in four transverse lines of about 10 each, though the lines are not exactly regular. Four or five disks form a semicircle at the median, anterior, and posterior margins of each oval, male pore area. Just anterior and slightly median to each semicircular row of disks there is a patch of four markings, probably on the anterior margin of xviii (17/18 not visible ventrally).

Internal anatomy.—Septa 5/6–7/8 are present, 6/7–7/8 slightly thickened; 8/9–9/10 absent; 10/11 and a few succeeding septa slightly thickened.

The intestine begins in xv. The intestinal caeca are compound, glove-shaped, with 4–7 secondary, anteriorly directed, fingerlike caeca; the dorsalmost secondary caecum the longest; the length of the caeca decreasing passing ventrally.

The last pair of hearts is in xiii.

The testis sacs of x and xi are ventral and unpaired. The seminal vesicles are fairly large, in contact transversely over the dorsal blood vessel. The prostates extend through segments xvii or

xviii–xxii. The prostatic duct, which extends through several segments, is elongate: the entalmost portion thin, whitish, with one small kink; the middle portion about 4 mm in length, thick, almost straight; the ectal portion thinner and curled or twisted.

The spermathecal duct is shorter than the ampulla and is narrowed in the parietes. The diverticulum is elongate and looped in a more or less zigzag fashion.

There are stalked glands in x anterior to 10/11 and in xviii. The stalks of these glands are slender but firm and longer than the stalks of somewhat similar glands in *P. hawayana* and *P. diffringens*.

Remarks.—The account above agrees, on the whole, with that given by Chen for his var. *omeimontis*. One of Chen's worms lacks the characteristic patch of genital markings on xi, but it does have genital markings in the region of the spermathecal pores. The variant specimen may be abnormal or possibly specifically distinct.

As has already been noted on a previous page, Fang's *P. paraglandularis* is a synonym of *P. aspergillum*. The Szechwan worms are clearly distinguished from *aspergillum* by the presence of a patch of closely crowded genital markings on xi. Var. *omeimontis* must accordingly be raised to the status of a species.

PHERETIMA PAETA Gates

1935. *Pheretima paeta* GATES, Smithsonian Misc. Coll., vol. 93, no. 3, p. 13 (type locality: Song Pan, Szechwan; types in the U. S. National Museum).

1936. *Pheretima paeta* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol 11, p. 300 (after examination of types).

Material examined.—From Dr. Graham: 4 specimens labeled "Song Pan, mouth of the Yellow Dragon Gorge, July 26, 1924"; 1 specimen labeled "Yellow Dragon Gorge near Song Pan, 12,000–13,000 feet, July 25–26, 1924."

External characteristics.—Length, 75–136 mm. Diameter, 5–6 mm.

The setae begin on ii, on which segment there is a complete circle. The ventral setae of ii–ix are slightly enlarged. A midventral gap in the setal circles is lacking or very slight, a middorsal gap of variable width present. The setal numbers are as follows:

viii	xvii	xviii	xix	xx	First dorsal pore
22	19	16	21	----------	12/13
23	18	13	24	----------	12/13
22	21	13	22	----------	12/13
24	----------	14	----------	65	11/12
24	----------	10	----------	68	12/13

The first dorsal pore is on 11/12 or 12/13.

Two specimens have no clitellar glandularity at all; three specimens have slight traces of clitellar glandularity on xiv–xvi.

The secondary spermathecal apertures are two pairs on 7/8–8/9; the apertures wide slits that open into deep depressions. If the margins of a depression are separated, the minute primary spermathecal pore may be seen, with favorable illumination, at the center of a smooth, flat, circular to oval area on the roof of the depression.

On xviii on each side, on the least mature specimen, there is a rather deeply bowed, crescentic slit, with its concave margin directed midventrally. The slit opens into a parietal invagination, which is deepest laterally and rather shallow toward the median ends of the crescent. The lateral wall of the invagination is thin and lacks setae. On the median wall of the invagination is a ridge of tiny lobes or roughened projections, continuous with the circumferential ridge on which the setae are located, but no setae were found in or between the lobes. Median to the slit but between the anterior horn and the setae is a transversely oval, flat-surfaced, slightly protuberant tubercle. On another specimen the lateral portion of this presetal tubercle is within the parietal invagination (here deeper); before the whole of the tubercle can be seen the lateral lip must be cut or drawn aside. On the maturest specimen the presetal tubercle is entirely within the invagination (in reality in this worm a copulatory chamber) and not visible until the chamber is cut open. The aperture on this specimen is larger and nearly circular.

There may be a second tubercle on xviii, postsetal in position and in line with the presetal tubercle and of about the same size and appearance. On the dorsal roof of the invagination are 2 or 3 additional tubercles of varying shape and size, on one of which the minute male pore is located.

The preclitellar genital markings are symmetrically paired on vii and viii, on the posteriormost margins of the segment, almost on the intersegmental furrows, each marking 1–3 intersetal intervals median to the spermathecal pore. On the most nearly mature specimen these markings are slightly protuberant and may be called tubercles. On the other specimens the markings are scarcely visible, the boundary of each marking represented by a very slight furrow. Curiously, a porelike depression at the center of these markings is much more readily visible, as a rule, when the markings are only slightly developed.

Internal anatomy.—Septa 5/6–7/8 are slightly thickened; 8/9–9/10 lacking; 10/11–12/13 muscular.

The intestine begins in xv. The intestinal caeca are compound, with 3–11 anteriorly directed, secondary caeca, the dorsalmost the

longest. The dorsalmost caecum may have several tertiary caeca on its ventral margin, these usually ventrally directed. In one specimen these tertiary caeca are readily noticeable on each side, but the ventral secondary caeca are not visible from above (in the dorsal dissection) and were not noticed until the intestine was rolled well over to one side. It would be very easy to overlook ventral secondary caeca placed as were these.

The hearts of x are bound to the anterior face of 10/11 by connective tissue. The last pair of hearts is in xiii. All hearts of x–xiii pass into the ventral blood vessel.

The testis sacs are unpaired and ventral, one on the anterior face of 10/11 and the other on the anterior face of 11/12. The anterior margins of the sacs are bilobed; in xi the anterior ends of the lobes alone reach to 10/11. The seminal vesicles of xi and xii are large and in contact transversely over the dorsal blood vessel. In xiii there is a pair of small, stalked pseudovesicles, the head ovoidal or flattened anteroposteriorly into an oval disk. In xiv there is a pair of smaller pseudovesicles, the head rounded or flattened and lobed or crenulated. The prostates extend through xvii–xix or xx. The prostatic duct is 3–6 mm in length, bent into a **U**- or **C**-shape, the ectal portion thickened. In the maturest specimen there are large copulatory chambers projecting conspicuously into the coelomic cavity. In the other three specimens there is no trace of a copulatory chamber projecting into xviii, the male pore invagination entirely confined at this stage to the parietes.

The spermathecae are obviously juvenile even in the maturest specimen. Careful removal of the longitudinal musculature shows the spermathecal duct (?) passing through the parietes without any decrease in diameter but on the contrary in at least one specimen a slight increase in thickness. The ectal end of this thick duct contains the invagination within which is the true spermathecal pore. Pulling the duct out from the parietes leaves an unusually wide transverse slit on the intersegmental furrow. The diverticulum comprises an ectal, smooth, thick-walled but slender stalk and a thinner-walled, sometimes slightly wider, elongate seminal chamber that is bent back and forth in a zigzag fashion, the limbs of the loops approximated and usually all in the same plane.

Just median to the prostatic duct are two glandular masses projecting slightly into the coelomic cavity. In one specimen minute stalked glands were found among the longitudinal muscle fibers in the region of the preclitellar genital markings.

Remarks.—The most nearly mature specimen is broken, the surface of the anterior segments damaged in places by gravel. Another specimen is softened. With full maturity the spermathecal

pore invaginations may be deepened, possibly but not probably developing into spermathecal chambers. The development of the copulatory chamber from a parietal invagination like that characteristic of certain species, such as *P. tschiliensis* Michaelsen, 1928, is noteworthy.

P. paeta is distinguished from *P. omeimontis* by the copulatory chambers and even in young aclitellate specimens by the parietal male pore invaginations. From *P. schmardae* (Horst, 1883) *P. paeta* is distinguished by the invaginate spermathecal pores, the median location of the copulatory chamber glands, and the presence of preclitellar genital markings. A satisfactory diagnosis of *P. paeta* cannot, of course, be given until fully clitellate specimens have been available for study.

PHERETIMA PAPILLIFERA Gates

1935. *Pheretima papillifera* GATES, Smithsonian Misc. Coll., vol. 93, no. 3, p. 13 (type locality: Yachow, Szechwan; type in the U. S. National Museum).
1936. *Pheretima papillifera* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 11, p. 300 (after examination of type).

Material examined.—From Dr. Graham: 1 clitellate specimen labeled "Near Yachow."

External characteristics.—Length, about 100 mm. Diameter, 4 mm.

Setae begin only on iv, on which segment there are but a few scattered ventral setae. There are middorsal gaps of varying width in the setal circles and a fairly regular but slight midventral gap. The setae are small and closely crowded, but with frequent asetal gaps. Setal formula: vi/11 +, vii/13 +, xvii/8 +, xviii/10, xix/10, xx/*ca.* 41 (+ denotes asetal gaps).

The first dorsal pore is on 11/12.

The clitellum is annular, extending from 13/14 to 16/17; intersegmental furrows and dorsal pores lacking; no setae visible.

The spermathecal apertures are minute, widely separated, three pairs, on 5/6–7/8.

The male pores are minute. On the left side the male pore is at the center of a circular, smooth area, which is demarcated by a slight furrow. No definite male pore area can be discovered on the right side.

The genital markings are circular, about 1–1½ intersetal intervals wide, presetal, fairly closely paired, one pair on each of segments xi–xiv. The last pair are in contact with the whitened, transversely oval area on which the female pore is located.

Internal anatomy.—Septa 5/6–7/8 and 10/11–12/13 are thickly muscular; 8/9–9/10 lacking.

The intestine begins in xv. The intestinal caeca are long, slender, and simple, dorsal and ventral margins practically smooth.

There is a single heart belonging to ix, on the right side. The hearts of x are bound to the anterior face of 10/11 by connective tissue. The last pair of hearts is in xiii. All hearts of ix–xiii pass into the ventral vessel.

There are two testis sacs on the anterior face of 10/11, the sacs completely separated from each other and without transverse communication. There is also a pair of testis sacs in xi without transverse communication. The seminal vesicles are either attached to the dorsal surfaces of these testis sacs or are contained within the sacs. The prostates extend through xvii–xix. The prostatic duct is about 5½ mm in length and variously twisted.

The spermathecal duct, which is abruptly narrowed deep in the parietes, is stoutish, firm, and glistening, as long as or slightly shorter than the ampulla. The diverticulum passes into the anterior face of the duct in the parietes, is shorter than the combined lengths of duct and ampulla, and comprises a very short, firm, smooth, glistening stalk portion and a slightly wider, more irregular, ental portion.

There are no glandular masses in the parietes in the region of the spermathecal ducts and the prostatic ducts. There is a glandular mass sessile on the parietes over each genital marking.

Remarks.—The condition of the right male pore region and the distribution of the setae indicate that the specimen is abnormal.

The type locality is Yachow, according to Dr. Graham (*in litt.*), not "Zachoo" as previously spelled (Gates, 1935, p. 13).

P. papillifera is distinguished from *P. abdita* by the superficial male pores, from *P. tuberculata* Gates, 1935, by the simple intestinal caeca, and from *P. hawayana* by the genital markings on xi–xiv.

PHERETIMA PECTENIFERA Michaelsen

1931. *Pheretima* (*Ph.*) *pingi* (part) + *P.* (*ph.*) *pectenifera* (in part only?) MICHAELSEN, Peking Nat. Hist. Bull. vol. 5, pt. 3, pp. 2, 11 (type locality of *pectenifera:* Soochow; types in the Hamburg Museum); Zool. Jahrb. (Abt. Syst.), vol. 61, pp. 561, 564.

1933. *Pheretima yamadai* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 9, p. 255 (part) (excluding "A" forms at least, and from synonymy *P. yamadai*).

1935. *Pheretima pectenifera* GATES, Smithsonian Misc. Coll., vol. 93, no. 3, p. 13.

1936. *Pheretima yamadai* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 11, p. 255.

Material examined.—From the Hamburg Museum: 3 clitellate specimens from a tube labeled "*Pheretima* (*Ph.*) *pectenifera* Mich.

Originale. Soochow. Biol. Station leg."; 4 specimens from a tube labeled "*Pheretima* (*Ph.*) *pingi* Steph. Soochow. Biol. Station leg."

External characteristics.—Length, to 220 mm. Diameter, to 10 mm.

The setae begin on ii, on which segment there is a complete circle. The setal circles are unbroken midventrally; a slight middorsal break may be present. Setal formulae of 7 specimens are as follows, the first four from the tube labeled *P. pingi:*

vii	viii	xvii	xviii	xix	xx
30	32	32	34	29	78
27	29	25	30	26	82
27	29	26	26	24	----------
28	29	27	29	25	----------
29	29	28	30	27	76
31	31	38	39	28	----------
39	36	29	36	33	97

The first dorsal pore is on 12/13 (7 specimens).

The clitellum is annular, extending from 13/14 to 16/17; dorsal pores, intersegmental furrows, and setae lacking.

The spermathecal pores are minute, widely separated; three pairs, on 6/7–8/9.

Each minute male pore is located at the center of an area of grayish translucent appearance. The area is rather small and approximates to elongate-oval in outline. The whole of the male pore area may be visible on the ventral face of a male porophore, with a slight suggestion of a lip just lateral to the area, or the area may be slightly sunk and the lip more evident or the area may be more deeply sunk in the parietes and invisible from the exterior, completely covered over by a lateral lip. On each male pore area there are four tiny circular markings, anterior, posterior, lateral, and median to the male pore. The anterior and posterior markings are slightly larger than the other two. The margins of the markings are rather definite but can be recognized as such only with brilliant illumination and high magnification.

The male porophores are broad low protuberances approximating to circular in outline and extending across xviii and slightly onto xvii and xix. The ventral face of a porophore may be rather flat or a lateral portion on which the male pore area is located may be especially protuberant. On the ventral face of the porophore median to the male pore area are four sharply defined, circular, grayish-translucent genital markings, each of which is larger than the markings on the male pore area.

These markings are not in contact and usually are so placed as to form four corners of a square, with two of the markings presetal and two postsetal. This arrangement is, apparently, quite characteristic, as the only variation on any of the seven worms is the absence of the median presetal marking of one or both sides. The male setae of xviii are continued onto the porophore nearly to the male pore area, but on the ventral face of the porophore they are smaller and more closely crowded than midventrally. The setae in the region between the two pairs of genital markings, on some specimens, are so closely crowded as to be forced anteriorly or posteriorly out of line in such a way as to produce a zigzag appearance. A similar zigzagging of a setal row is apparent on two specimens, on xvii on each side just anterior to the male porophore.

The male porophores certainly represent an everted condition of some sort of a male pore invagination. In a carefully dissected specimen the porophore can be retracted at least partially. If, in a completely retracted condition, there is a true copulatory chamber, then the four genital markings and the small closely crowded setae will probably be withdrawn into the interior of the chamber. A lateral lip similar to that which can be seen on those specimens with slightly retracted male pore areas is, however, usually associated with a deep parietal invagination, which does not reach through the body wall into the coelomic cavity. If the male pore invagination in *P. pectenifera* is a parietal invagination of this sort, then in a retracted condition the four genital markings and the small closely crowded setae may be invisible from the exterior.

Aside from the markings on the ventral face of the male porophore there are no postclitellar genital markings. The preclitellar genital markings are of two sizes. The smaller markings are on the posteriormost margins of vi–viii in close proximity to the spermathecal pores. There are usually three of these markings, one immediately anterior to, one immediately lateral to, and one immediately median to each spermathecal pore, but both the lateral and median markings may be lacking or only the anterior marking. These markings and the spot on which the spermathecal pore is located are of a grayish translucence and so closely crowded together that identification of the spermathecal pore and of the margins of the markings is difficult.

The larger, paired markings are presetal on vii, viii, and ix and postsetal on vii and viii; each marking in 5–8 intersetal intervals median to the spermathecal pore and usually slightly nearer to the setae than to the intersegmental furrow. One marking of a pair may be lacking, or an additional marking may be present close to one of the usual markings. The presetal markings of ix are lacking

on 5 specimens; the presetal markings of vii lacking on 2 specimens; the postsetal markings of viii lacking on 1 specimen. Each marking is circular, about 1 intersetal interval in diameter, of a grayish translucence, delimited by a slight circumferential furrow and with a peripheral rim portion slightly elevated.

Internal anatomy.—Septa 5/6–7/8 are thickened; 10/11 strengthened but translucent; 11/12–13/14 slightly strengthened; 8/9–9/10 lacking.

The intestine begins in xv (4 specimens). The intestinal caeca are compound, glove-shaped. Each caecum is composed of 5–7 elongate and fingerlike secondary caeca. The dorsalmost secondary caecum is usually longer than the other secondary caeca, but in one specimen all the secondary caeca are of about the same length. The secondary caeca usually have smooth dorsal and ventral margins, but there may be one or two short but definitely fingerlike tertiary caeca on the ventral margin of any particular secondary caecum. The typhlosole begins just behind the caeca.

There is a pair of hearts belonging to ix in one specimen; a single heart belonging to ix in three specimens, on the right side (1 specimen) or the left side (2 specimens). The last pair of hearts is in xiii (4 specimens). The hearts of x are filled with blood and readily recognizable. All hearts of ix–xiii pass into the ventral blood vessel.

The testis sacs are unpaired and ventral. The seminal vesicles of xi and xii are fairly large and are in contact transversely above the dorsal blood vessel. Each vesicle has a well-developed primary ampulla, conical to pyramidal in shape, the base of which is sunk into the dorsal margin of the ventral lamina. The ampulla is deeply constricted off from the ventral lamina, in one specimen the two portions of the vesicle connected only by a slender cord. The prostates extend through some or all of segments xvi–xxii. The prostatic duct is 8–10 mm in length, bent into a hairpin loop, the ectal limb much thicker than the ental limb.

On the parietes just median to the ectal end of the prostatic duct there are two transversely ovoidal masses of softish, glandular tissue. Each of these masses can be separated, when all genital markings are present, into two distinct masses, each with its own duct passing into the body wall. Within or on the parietes but closer to the prostatic duct are four smaller and more nearly spheroidal glandular masses, the stalks or ducts of which pass to the four genital markings on the male pore area.

The spermathecal duct is muscular, with a smooth, glistening, pinkish appearance, the length equal to or less than that of the ampulla. The diverticulum passes into the median face of the duct

close to the parietes; ectal to this junction the duct much narrowed. The diverticular stalk is very short, always shorter than the spermathecal duct and like the duct is smooth, glistening, and muscular. The seminal chamber is long and thin walled; the chamber may be almost straight, bent, twisted, or with one or two very short loops, the limbs of the loops in apposition.

A glandular mass projects from the parietes into the coelomic cavity in front of each spermatheca. The glandular mass comprises one, two, or three distinct glands, according to the number of genital markings in close proximity to the spermathecal pore. A short ental portion of the gland duct of the larger preclitellar, genital markings is coelomic, lifting the gland into the coelomic cavity slightly above the parietes.

Remarks.—In the translation of the description of *pectenifera*, Dr. Boring (Michaelsen, 1931) has made several mistakes. On page 16 the statement regarding intestinal caeca should read, "The size of the caeca *decreases* regularly from above downwards" i. e., passing ventrally. Further corrections: The seminal vesicles of xi are *not* grown together above the intestine; the seminal vesicles of xii are *not* fused ventrally; the testis sac of xi does *not* "extend over" the anterior testis sac but over the anterior seminal vesicles.

The three types of *P. pectenifera* are all characterized by minute spermathecal pores. According to Michaelsen the spermathecal pores are "ziemlich grosse Querspalte." The size of spermathecal pores is not subject intraspecifically to such extremes of variation as this would appear to indicate. Either Michaelsen is mistaken with regard to the size of the spermathecal pores or else the original material comprises two specifically distinct forms (one with large spermathecal pores or minute but invaginate pores communicating with the exterior by large secondary openings).

Furthermore, the testis sacs in the three types are ventral, but according to Michaelsen the posterior sac is (Michaelsen considers the single sac to be in reality a pair of sacs "in ganzer Breite miteinander verschmolzene") "nicht geschlossen" that extends over, "ubergehen," the seminal vesicles of xi. What the author means by an "open" testis sac (in *Pheretima* the sacs are always closed) that "passes over" the seminal vesicles is not clear unless the anterior vesicles are included within the posterior testis sac. But the vesicles of xi of the types examined are not so included. Possibly the type series of *pectenifera* comprises two species, one with included and one with excluded seminal vesicles.

The male pore region of *P. pectenifera* is so remarkably like that figured for *P. yamadai* Hatai, 1930, that the former may be, in reality, a synonym of the latter. Hatai's species is not, however, ade-

quately characterized, and inasmuch as types or specimens of *P. yamadai* have not been available for examination Michaelsen's species is retained. If Michaelsen's species is in fact composite and actually in part a synonym of *yamadai*, the name *pectenifera* will have to be retained for the remaining part.

PHERETIMA PINGI Stephenson

1925. *Pheretima pingi* STEPHENSON, Proc. Zool. Soc. London, 1925, p. 891 (type locality: Nanking; type in the British Museum).
1931. *Pheretima pingi* MICHAELSEN, Lingnan Sci. Journ., vol. 8, p. 159.
1931. *Pheretima pingi* STEPHENSON, Proc. Zool. Soc. London, 1931, p. 55.
1931. *Pheretima* (*Ph.*) *pingi* MICHAELSEN, Peking Nat. Hist. Bull., vol. 5, pt. 3, pp. 2, 11 (part); Zool. Jahrb. (Abt. Syst.), vol. 61, p. 56 (part) (Nanking; specimens in the Hamburg Museum).
1933. *Pheretima pingi* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 9, p. 228 (part only?) (excluding forms with no spermathecae in v ?).
1934. *Pheretima kyamikia* KOBAYASHI, Journ. Chosen Nat. Hist. Soc., vol. 19, p. 1 (type locality: Korea; types ?).
1935. *Pheretima pingi* GATES, Smithsonian Misc. Coll., vol. 93, no. 3, p. 14.
1936. *Pheretima carnosa* KOBAYASHI, Sci. Rep. Tohoku Univ., ser. 4, vol. 11, p. 115 (part), excluding from synonymy *hawayana* Gates, 1932).

Material examined.—From the British Museum: 1 specimen labeled "*Pheretima pingi* Stephenson. Holotype. 1924.11.29.5. Nanking, China"; From S. Kobayashi: 1 clitellate specimen labeled "*Ph. kyamikia* Kobayashi (Tetsugen) Kogen-do" (this specimen is unusually well preserved). From the U. S. National Museum: 18 specimens labeled "Kiangsu, Nanking. National Southeastern University by C. Ping." From Dr. Graham: 1 clitellate specimen labeled "Near Mupin, 7,000–13,000 feet, July 8, 1929."

External characteristics.—Length, 120–190 mm. Diameter, 5–7½ mm.

The setae begin on ii, on which segment there is a complete circle. The setae of ii-viii or ix are enlarged, especially ventrally. From viii or ix, passing posteriorly, the size of the setae decreases, the setae of xvii larger than those of xix but smaller than those of xi; the setae of the posteriormost segments slightly larger than those in segments of the middle of the body. The setal numbers are indicated as follows:

vi	vii	viii	xvii	xviii	xix	xx	First dorsal pore
14	15	18		22			12/13
16	16	20		19			12/13
14	16	18		20			12/13
13	14	17		20			12/13
16	16	20	(17–24)	21	(19–26)	(57–64)	12/13
16	18	21		16			11/12
13	14	16		19			11/12
14	14	17		18			11/12
11	11	14		15			[1] 12/13
------	--------	--------	26	20	26	66	[2] 12/13

[1] From Mupin.
[2] Kobayashi's specimen (33/iii, 40/vi, 46/viii, 62/xii).

The first dorsal pore is on 11/12 (3 specimens), 12/13 (14 specimens), or 13/14 but with a definitely porelike marking on 12/13 (3 specimens).

The clitellum is annular, extending from 13/14–16/17; intersegmental furrows and functional dorsal pores lacking though porelike markings are sometimes present; a few scattered setae present ventrally on some or all of segments xiv–xvi.

The spermathecal pores are minute, widely separated, on tiny tubercles; four pairs, on v–viii, just anterior to the intersegmental furrows, the latter clearly visible just behind the pores.

Each minute male pore is located at the center of a circular, smooth, glistening disk, which is marked off by a slight but definite circumferential furrow. A male pore disk may be at the general epidermal level, slightly depressed *in toto* or folded and depressed at the fold. In the latter case there is rather superficial resemblance to the transversely slitlike opening of a copulatory chamber. The disks of Kobayashi's specimen are 3 intersetal intervals wide transversely.

The genital markings are circular to transversely oval or thickly crescent-shaped. The latter are postsetal protuberances (often smooth and glistening) on the posterior margins of v–viii, so placed that the tiny spermathecal pore tubercle is within the concave posterior margin of the crescent. Other genital markings are not so close to the intersegmental furrows; 1½–4 intersetal intervals wide transversely, with a more or less easily recognizable, thick, cream-colored rim and a grayish or brownish, translucent, central portion that may be flat, concave, or convex. The markings are symmetrically paired, presetal on viii, ix, xviii, and xix and postsetal on xviii. On 10 specimens the markings are located as follows:

Segment	Location	Specimens
viii	Each marking just lateral to the midventral line	2
viii	Each marking just median to the spermathecal pore line	4
ix	Each marking just lateral to the midventral line	4
ix	Each marking just median to the spermathecal pore line	6
xviii	Each presetal marking immediately median to the male pore disk	4
xviii	Each presetal marking just lateral to the midventral line	3
xviii	Each postsetal marking median to the male pore disk but not as close to the disk as a lateral, presetal marking.	10
xix	Each presetal marking in line with or about in line with the postsetal marking of xviii.	5

Of the remaining nine (U. S. N. M.) specimens five have symmetrically paired markings on the locations indicated above. Four worms lack one of a pair of markings. Of these last, two have one or two unpaired, median, presetal markings, one on viii, or one each on viii and ix. On Kobayashi's specimen, in addition to the crescentic, postsetal markings just in front of the spermathecal pores, there is a presetal marking in *cd* on each side of viii and ix, a presetal marking in *cd* on each side of xviii, and a postsetal marking in *jk* on xviii on each side.

Internal anatomy.—Septa 5/6–7/8 are thickly muscular; 8/9 complete but thin, pushed posteriorly into a funnel-shape by the gizzard; 9/10 lacking; 10/11–12/13 thickly muscular; 13/14 slightly muscular.

The intestine begins in xv, but when the gut is empty that portion of the intestine anterior to 15/16 may be invaginated posteriorly into the gut lumen of xvi, so that the intestine appears to begin in xvi or with 15/16. If the gut in xvi is carefully opened the invaginated portion can be pushed anteriorly into xv so that the origin in xv is clearly recognizable. The intestinal caeca are simple: the dorsal and ventral margins smooth or constricted slightly by the septa through which the caeca pass, occasionally the ventral margin provided with a few slight additional incisions.

One or both hearts of ix may be present. In either case the heart or hearts are posterior to the first postgizzard septum, which must therefore be 8/9. The hearts of x are present but are small and not easy to find when empty, as they are bound to 10/11 by connective tissue. In Kobayashi's specimen the left heart of x is filled with blood and is as large as the heart (left) of ix. The right heart of x is small and empty. The last pair of hearts is in xiii. All hearts of ix–xiii pass into the ventral trunk. (Hearts of x were not found in the type.)

The lymph glands in xv–xxvi are elongate, finger-shaped; from xxviii posteriorly they are flattened, leaflike bodies, often bilobed or trilobed.

The testis sacs of x and xi are unpaired and ventral. The seminal vesicles of xi and xii are in contact transversely over the dorsal blood vessel. Each vesicle has a rounded, primary ampulla, with a smooth or finely granular surface. The lateral face of the ventral lamina of each vesicle has a convoluted appearance. When the delicate transparent sheath surrounding the ventral lamina of a vesicle is removed, the contents separate into columnar blocks. These blocks are so placed within a vesicle that the long axes are mesiolateral. The prostates extend through some or all of segments xvi–xx. The prostatic duct is 5–8 mm long, usually bent into an elongate, hairpin-shaped loop, the ectal limb of the loop slightly thicker than the ental limb.

The spermathecal duct is smooth and slender, about as long as or slightly shorter than the ampulla; narrowed gradually in the parietes. The diverticulum is not so long as the combined lengths of duct and ampulla and passes into the anterior face of the duct close to the parietes. The smooth, slender stalk is 2–3 times the length of the seminal chamber, which may or may not be sharply marked off from the stalk. In Kobayashi's specimen the chamber is but slightly shorter than the stalk but 1½ times as thick. In each of several spermathecae there is a single very short loop in the diverticular stalk just ectal to the seminal chamber.

The glandular masses dorsal to the genital markings appear to be sessile on the parietes. The glands over the circular to oval markings are rather disklike; the postclitellar glands not so flat and more conspicuously protuberant into the coelomic cavity than the preclitellar glands.

The glandular material of the spermathecal pore markings is usually in the form of a "half-collar" in the parietes on the anterior face of the spermathecal duct. In this collar there can be seen a number of very fine stalks or ducts, which pass onto the anterior face of the spermathecal duct to which they are firmly attached. Occasionally and especially anterior to the spermathecae of vi and vii the glandular material is not aggregated into a half-collar but is represented by small bits of softish material between the longitudinal muscle bundles.

Remarks.—The "externally projecting chambers" present on the spermathecal ducts of the type are lacking in all but two of the specimens examined. In one of the exceptional specimens there are vesicular bodies on the duct of each spermatheca. In the second specimen only a few of the spermathecae are so characterized. These saclike or vesicular protuberances are thus not characteristic of the species. Quite possibly the vesicular outgrowths are the result of parasitic activity.

P. pingi is close to *P. diffringens*, from which it is distinguished by the slightly larger setal numbers, the larger number of male setae on xvii–xix, the posterior location of the first dorsal pore, the segmental and postsetal location of the spermathecal pores, the presence of postclitellar genital markings, presence of a complete septum 8/9, and presence of the hearts of x. The segmental location of the spermathecal pores is not obvious unless the specimens are well preserved.

Kobayashi (1936) places *pingi* in the synonymy of *carnosa* as a result of his examination of two octothecal Japanese specimens (from Morioka) with spermathecal pores on 5/6–8/9 that were labeled "*P. carnosa*." Unfortunately no history is given of these specimens of *carnosa*, and there is no valid reason for accepting Kobayashi's synonymy at present. The types of *carnosa* are from Tokyo and are sexthecal, with spermathecal pores on 5/6–7/8. Although Kobayashi claims to have had sexthecal specimens of *pingi*, the spermathecal pores on both of these specimens are on 6/7–8/9.

Kobayashi (both in 1934 and 1936) considers the spermathecal pores to be large. The pores are, however, at least on the specimen just examined, minute and superficial. Large spermathecal pores would have to be considered evidence for recognition as a distinctly different species.

PHERETIMA POMELLA Gates

1935. *Pheretima pomella* GATES, Smithsonian Misc. Coll., vol. 93, no. 3, p. 14 (type locality: Suifu, Szechwan; types in the U. S. National Museum).
1936. *Pheretima pomella* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 11, p. 301 (after examination of type).

Material examined.—From Dr. Graham: 1 clitellate specimen labeled "Suifu, 1,200–2,000 feet, October 1–November 1, 1938."

External characteristics.—Length, 87 mm. Diameter, 5 mm.

Setae are present ventrally on segment ii but are lacking dorsally; the dorsal gap narrows gradually on iii–v. On the postclitellar segments the middorsal gaps are variable in width. There is a definite but slight midventral gap from segment xxi posteriorly. Setal numbers: vii/19, xvii/19, xviii/14, xix/19, xx/*ca.* 50.

The first dorsal pore is on 10/11.

The clitellum is annular, extending from 13/14 to 16/17; intersegmental furrows, dorsal pores, and setae lacking.

The spermathecal pores are minute, on tiny glistening tubercles; presetal on vii and viii, slightly nearer to the intersegmental furrows than to the setae.

The male pores are minute, each pore at the center of a very short, slightly depressed, transverse area; the margins of the areas not definitely demarcated or demarcations unrecognizable because of the slight depression.

Immediately anterior and just posterior to each male pore is a transversely oval genital marking, about 1 intersetal interval wide, with a thick whitish rim and a grayish depressed center. Just in front of each anterior marking and just behind each posterior marking is a raised, transversely oval, whitish (glandular ?) patch. The centers of these patches are very slightly median to the centers of the genital markings. The centers of the genital markings are about in line with the male pores. There are two pairs of preclitellar genital markings, presetal on xii and xiii. These markings are round to transversely oval, about 2 intersetal intervals wide transversely, the markings of a pair separated by a midventral distance slightly greater than *aa*. Each marking has a flat grayish center, which is wider than the central portion of a postclitellar marking, and a whitish rim. The markings are slightly nearer to the setae than to the intersegmental furrows.

Internal anatomy.—No septa are thickly muscular; 8/9–9/10 lacking.

The intestine begins in xvi. The intestinal caeca are simple, constricted slightly by the septa through which they pass.

The last pair of hearts is in xiii. All hearts of ix–xiii pass into the ventral vessel.

The testis sacs of x and xi are unpaired and ventral. The anterior margins of both sacs are bilobed. The seminal vesicles of xi and xii are fairly large, in contact transversely above the dorsal blood vessel. The prostates are confined to xvii–xviii. The prostatic ducts are about 3 mm long, of nearly the same thickness throughout, bent into a C- or a U-shape.

The spermathecal duct is shorter than the ampulla and is narrowed within the parietes. The diverticulum passes into the duct close to the parietes and comprises a short, slender stalk and a thicker, longer seminal chamber that is twisted into a mass of loops. There are masses of iridescent material (spermatozoa) in the seminal chambers.

Remarks.—There are cystlike bodies on the spermathecal seminal chambers, probably abnormal. Possibly some of the supposedly specific characters of this worm are also abnormalities.

P. pomella is distinguished from *P. planata* Gates, 1926, by the more posterior location of the spermathecal pores, the posterior location of the preclitellar genital markings, the absence of copulatory chambers, and the ventral testis sacs.

PHERETIMA PRAEPINGUIS Gates

1935. *Pheretima praepinguis* GATES, Smithsonian Misc. Coll., vol. 93, no. 3, p. 15 (type locality: Mount Omei, Szechwan; type in the U. S. National Museum).

1936. *Pheretima praepinguis* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 11, p. 302 (after examination of type).

Material examined.—From Dr. Graham: 1 clitellate specimen labeled "Mt. Omei, 4,400 feet."

External characteristics.—Length, 207 mm; a posterior portion probably lacking. Diameter, 16 mm.

The setae begin on ii, on which segment there is a complete circle. There is no definite midventral gap in the setal circles; the middorsal gaps of variable width. Setal numbers: vii/23, viii/24, xvii/20, xviii/9(+4?), xix/22, xx/93.

The first dorsal pore is on 12/13.

The clitellum is annular and extends from 13/14 to 16/17; only very slight traces of intersegmental furrows and dorsal pores visible; circles of setal pits present on xiv–xvi but no setae visible.

The secondary spermathecal apertures are transverse slits; three pairs on 6/7–8/9; the margins of the pores finely wrinkled.

The apertures of the male parietal invaginations are rather crescentic, but the left aperture gapes open so widely that some of the structures within the invagination are visible from the exterior. The invaginations are deep but confined to the body wall; the lateral wall of the invagination thin, lacking setae. The ventral margin of the thin lateral wall forms a rather crescentic lip at the lateral side of the aperture into the invagination. The minute male pore is on the ventral face of a smooth, glistening, protuberant tubercle, which is located dorsally in the lateralmost portion of the invagination. The median wall of the invagination is raised into a slight ridge on which is located a single circular tubercle, the latter near to but not in contact with the male pore tubercle. At the center on the ventral face of the tubercle several grayish porelike markings are visible. On the median wall of the invagination near the aperture and anterior to the ridge is a transversely oval genital marking, with a grayish, translucent, central portion and a raised opaque rim. The presetal marking is about three times the size of the tubercle on the ridge.

The external genital markings are presetal; three pairs, on vii–ix. Each marking is transversely oval, circular or longitudinally oval, located on the anterior margin of the segment just median to the secondary spermathecal pore. The markings are not sharply demarcated, but a central portion of a grayish, translucent appearance and a slightly protuberant, opaque rim can be distinguished.

Internal anatomy.—Septa 5/6–7/8 are thickly muscular; 8/9–9/10 lacking; 10/11–12/13 thickly muscular; 13/14 muscular.

On the esophagus immediately behind the gizzard there is a conspicuous, lobed, glandular collar. The intestine begins in xv on the right side, in xvi on the left side. The intestinal caeca are simple.

The single commissure of ix is on the left side. The last pair of hearts is in xiii. All hearts of ix–xiii pass into the ventral blood vessel.

The testis sacs of x and xi are unpaired and ventral. The seminal vesicles of xi and xii are vertical bodies reaching into contact with the dorsal blood vessel. Each vesicle is provided with a rather conelike, very smooth, primary ampulla, which is sunk into the dorsal margin of the ventral lamina. There are paired pseudovesicles in xiii and xiv. The prostates are relatively rather small; the right prostate confined to xviii though 17/18 and 18/19 are dislocated anteriorly or posteriorly; a small lobe of the left prostate extending into xvii. The prostatic duct is about 12 mm long, bent into a hairpin-shaped loop, the ectal limb of the loop thicker than the ental.

The spermathecal ampulla is about as long as or slightly longer than the duct. The latter is stoutish and with a rather bulbous appearance as it passes into the parietes. Within the body wall the duct is very abruptly and very considerably narrowed; the very short, slender portion of the duct opening to the exterior by a minute pore on the ventral face of a tiny, smooth, rather conical tubercle on the roof of the spermathecal invagination. The spermathecal invagination, transversely slitlike in section, is confined to the outer half of the rather thick body wall. On the anterior face of the spermathecal duct, close to the parietes is a spheroidal, glandular mass. A bundle of stalks or ducts from this gland passes through the parietes on the anterior face of the spermathecal duct to a circular genital marking located on the anterior wall of the spermathecal invagination. The junction of the diverticular stalk with the spermathecal duct close to the parietes is concealed from view by the anterior gland. The diverticulum comprises a smooth, glistening stalk and a much wider seminal chamber, the latter with two or three slight constrictions.

Just median to each prostatic duct a glandular mass projects conspicuously into the coelomic cavity. This mass is elongate, sausage-shaped, but this is not at first obvious, for a portion of the gland passes in an anteroventral diagonal fashion deep into the parietes. From the ventral face of this mass numerous cords or ducts pass posteriorly within the longitudinal musculature.

Remarks.—Stalked glands or glandular masses in connection with the presetal genital markings were not found.

No setae were observed on the median wall of the male parietal invagination but unusually small or very deeply retracted setae may have been overlooked.

P. praepinguis is close to *P. tschiliensis* from which it may be distinguished at present by the location of the primary spermathecal pores in parietal invaginations.

Chen (1936, p. 302) maintains that *praepinguis* is a synonym of *tschiliensis* and that the type of the former is not only "perfectly identical" with some of Chen's earlier specimens from Szechwan but also with the types of *grahami*. *P. grahami* is quite clearly distinquished from *praepinguis* by the unusual spermathecal chambers and the presence of copulatory chambers. What Chen's earlier specimens from Szechwan actually are cannot be determined from his description. *P. praepinguis* is, as was stated above, close to *tschiliensis* and, of course, cannot be satisfactorily characterized from a single specimen. The spermathecal pores of one species are superficial but in the other species are within definite, or what appear to be definite, parietal invaginations with large transversely slitlike apertures, which would normally be shut so as to conceal the primary pore from sight externally. Such an invagination appears to be of sufficient importance to distinguish *praepinguis* from *tschiliensis*, in view of the lack of intraspecific variation with regard to the spermathecal pore. If the two forms are really specifically distinct, examination of additional specimens of each should disclose further distinguishing characteristics.

PHERETIMA ROBUSTA (E. Perrier)

1872. *Perichaeta robusta* E. Perrier, Nouv. Arch. Mus. Hist. Nat. Paris, vol. 8, p. 112 (no type designation; types from Mauritius and Manila in the Paris Museum).

1899. *Amyntas löhri* Michaelsen, Mitt. Naturhist. Hamburg, vol. 16, p. 12 (type locality: Shi-hui-yao near Wuchang, Hupei; types in the Hamburg Museum).

1931. *Pheretima siemsseni* (part) + *P. fokiensis* + *P. robusta* Michaelsen, Zool. Jahrb. (Abt. Syst.), vol. 61, pp. 571, 574, 577 (type locality of *siemsseni:* Foochow; of *fokiensis:* Fukien Province; types in the Hamburg Museum).

1931. *Pheretima* (*Ph.*) *hesperidum* (part, excluding all except *löhri*) + *P. siemsseni* (part) + *P. fokiensis* + *P. robusta* Michaelsen, Peking Nat. Hist. Bull., vol. 5, pt. 3, pp. 2, 17, 19, 21.

1931. *Pheretima* (*Ph.*) *corrugata* Chen, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 7, p. 131 (type locality: Kia-ting, Szechwan; types in the Museum of the Science Society of China).

1932. *Pheretima* (*Pheretima*) *lauta* Ude, Archiv für Naturg., new ser., vol. 1, p. 153 (Foochow; specimen in the Hamburg Museum).

1933. *Pheretima corrugata* + *P. lauta* (part only) CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 9, pp. 278, 282 [excluding from the synonymy of *lauta* the following: *lauta* Ude, 1905; *siemsseni* (part)]. (Chen distinguished two forms, coast and inland, part of which may have to be excluded.)

1935. *Pheretima robusta* GATES, Smithsonian Misc. Coll., vol. 93, no. 3, p. 15.

1935. *Pheretima robusta* + *P. ultoria* CHEN, Bull. Fan Inst. Biol. Peiping, vol. 6, pp. 36, 42 (type locality of *ultoria:* Hongkong; types in the Museum of the Fan Memorial Institute of Biology).

1936. *Pheretima robusta* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 11, p. 271.

1937. *Pheretima masatakae* KOBAYASHI, Sci. Rep. Tohoku Univ., ser. 4, vol. 11, p. 337.

THE FOLLOWING DOUBTFULLY PLACED IN SYNONYMY:

1933. *Pheretima corrugata* var. *kulingiana* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 9, p. 278 (type locality: Kiukiang, Kiangsi; types in the Museum of Zoology of Central University, Nanking).

1935. *Pheretima robusta* GATES, Lingnan Sci. Journ., vol. 14, p. 453 (after examination of a topotype of var. *kulingiana*).

1935. *Pheretima aspergillum* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 11, p. 120 (Amoy).

Material examined.—From the Hamburg Museum: 1 clitellate specimen (A) labeled "V 7356. *Pheretima robusta* (E. Perr.). China, Futschau. Consul Siemssen 1/d"; 1 clitellate specimen in two portions (B) labeled "V 6362–6193. *Pheretima lauta.* Consul Siemssen 1/d. China, Futschau"; 1 clitellate specimen (C) from a tube labeled "*Pheretima* (*Ph.*) *siemsseni* Mich. Originale. China, Futschau. Consul Siemssen leg."; 1 softened clitellate specimen (D) labeled "V 7728. *Pheretima fokiensis* Mich. Orig. China, Prov. Fukien. G. Siemssen. 1.d"; 1 aclitellate and 4 clitellate specimens (E) labeled "V 351. *Pheretima löhri* Mich. China, Prov. Hupei." From the U. S. National Museum: 1 softened clitellate specimen (F) from a tube labeled "Foochow, China. C. R. Kellogg, collector." From Dr. Graham (several specimens referred to collectively as G): 6 specimens labeled "Mupin, 3,500–5,000 feet, July 1, 1929"; 5 specimens labeled "Suifu, 1,400 feet, April 18, 1925"; 1 specimen labeled "Near Hai-Tang, 6,000–8,000 feet, August 14, 1928"; 1 specimen labeled "Uingin-shien, 2,500–7,000 feet, July 14–15, 1928"; 1 specimen labeled "38 miles east of Tatsienlu on the Kong River, 1,500 feet, June 20, 1923"; 2 specimens labeled "Tatsienlu, 12,000 feet, July 7–9, 1923; and (several specimens referred to collectively as H) 1 specimen labeled "South of Suifu, 1,000–1,500 feet, March 25–29, 1930"; 1 specimen labeled "Kang-shien, 1,300–3,000 feet, October 28–29, 1928"; 1 specimen labeled "Fu-Lin, 3,000 feet, July 18, 1928"; 2 specimens labeled "Between Taso-Jia-Geo and Tsang . . . ? (remainder illegible), 1,500–3,000 feet, Sept. 3–4, 1929"; 2 specimens labeled "Suifu, September 1924";

1 specimen labeled "Suifu, water specimens, May 24, 1928"; 1 specimen labeled "Suifu." From the U. S. National Museum: 2 clitellate specimens (I) labeled "*Pheretima corrugata* Chen (paratypes), Kia-Ting, Szechwan. Y. Chen."

External characteristics.—Length, 33–36 mm (E), 125 mm (G), 85–120 mm (H). Diameter, 2 mm (E), 4–6½ mm (G), 2½–6 mm (H).

The setae begin on ii, on which segment there is a complete circle. A midventral gap, when present, is slight, a middorsal gap present or lacking. The setae of ii–ix, at least ventrally, are enlarged. Enlarged setae from several specimens (including a paratype of *P. corrugata*) have been examined microscopically. The shaft is almost straight, the ectal tip ornamented with short, transverse rows of very fine spines. The setal numbers are as follows:

viii	xvii	xviii	xix	xx	Specimens
25	28	21	27	*ca.* 70	A
24	24	20	23	*ca.* 65	B
17	26	16	26	----------	C
26	24	21	23	*ca.* 65	D
19	----------	15	----------	----------	E
18	19	15	21	----------	E
17	----------	14	----------	----------	E
24	23	20	24	----------	F
16	16	13	16	46	G
16	17	13	19	58	G
18	15	15	19	62	G
15	19	13	19	----------	G
14	17	14	19	49	G
17	17	13	18	56	G
15	15	13	14	50	G
17	17	12	17	54	G
16	17	13	16	46	G
18	20	15	18	60	G
17	17	15	18	56	G
16	19	13	21	57	G
16	18	13	19	62	G
14	16	10	16	----------	G
16	23	15	22	----------	G
20	17	13	19	60	G
[1] 16	17	15	19	69	H
22	21	16	20	66	H
22	19	15	20	60	H
21	18	16	18	67	H
22	20	15	20	64	H
25	19	15	20	68	H
24	19	14	19	----------	H
19	21	16	22	----------	H
18	----------	16	----------	----------	H
22	21	15	19	72	H
[2] 16	21	15	20	----------	I
15	17	14	21	----------	I

[1] Wide ventral break with setal pits, if pits are counted as setae the number is 22.

[2] The epidermis damaged midventrally, the number possibly should be increased by 2 or 3.

The first dorsal pore is on 11/12 (31 specimens) but on two worms there are porelike but apparently nonfunctional markings on 10/11.

The clitellum is annular, extending from 13/14 to 16/17; dorsal pores and intersegmental furrows lacking; setae lacking except on three specimens, on each of which there are a few setae ventrally on xvi, a few further setae ventrally on xiv–xv on one specimen. The pores on 13/14 and 16/17 are functional.

The spermathecal pores are minute, widely separated, two pairs on 7/8–8/9, often on tiny, glistening, translucent tubercles. On specimens H the pores may be recognizable and apparently normal or abnormal in appearance or unrecognizable.

Each minute and superficial male pore is at or near the center of a small tubercle of circular to transversely elliptical outline, the tubercle surrounded by several concentric furrows, which are also circular or elliptical. On specimens A, B, C, D, and F the male pore is on the median portion of the male pore tubercle and on the lateral portion of the tubercle there is a gland pore or pores.

In the specimens H and I the male pores are invaginate, the apertures of the invaginations transversely slitlike, the invaginations slight. The slit is surrounded by a circumferential, elliptical lip, which is marked off on its outer margin by a groove also elliptical in outline. Beyond this groove there are 2–3–4 additional, similar, concentric grooves. The aperture of the male invagination may be closed or may gape open so that the interior is visible. In specimens I the lumen of the invagination is nearly filled by a transverse row of two tiny rounded tubercles, each with a pore on the ventral face. In most of the other specimens in place of these two papillae there is a low, transverse ridge, anteroposteriorly compressed and more or less bladelike. The lateral portion of this ridge usually widens as it passes dorsally more noticeably than does the median portion. On the lateral portion of the ridges there is usually recognizable a marking that contains the site of the male pore, but the marking does not have quite the appearance of a normal male porophore. On the ventral face of the median portion of the ridge another more or less definitely demarcated marking may be visible.

In the setal circle of xviii (specimens E), separated by 14 or 15 setae are two transversely oval, flat areas, each of which is surrounded by two or three concentric and rather elliptical furrows. The innermost of the concentric furrows is the deepest, but there is no indication of the presence of a copulatory chamber or parietal invagination. The cuticle adheres tenaciously to the male pore areas and can be removed only by scraping. Although the scraping was done as gently as possible the surface of the areas was more or less damaged, so that pores are not definitely recognizable. The presence

of a stalked gland just median to the ectal end of the prostatic duct indicates that two pores should be present on each area—a median gland pore and a lateral male pore.

The genital markings are small, about 1 intersetal interval wide transversely; circular to transversely oval; each marking with a depressed, grayish-translucent center and an opaque, whitish, protuberent rim. Each of the midventral markings on xviii may be surrounded by 2 or 3 concentric circular furrows.

Presumably the grayish-translucent appearance of the central portion of a marking is the result of the crowding closely together of a number of pores, each of which has the appearance of a black dot. The recognition of distinct pores is exceedingly difficult except when the specimens are softened.

Just median to the male pore tubercles (specimens G) there are genital markings of similar shape and size. These markings are on the area crossed by the concentric furrows and are usually located between two consecutive furrows. On eight specimens there are two markings near each male pore tubercle, one presetal and one postsetal. On three specimens presetal markings alone are present on xviii. On two specimens one of the postsetal markings is lacking. On another specimen there are two extra presetal markings on the left side and one extra presetal marking on the right side. On another specimen there is an extra presetal marking on one side but on the other side the male pore region has an appearance very similar to if not exactly the same as that in *corrugata*. In this worm the prostate is lacking on the side having the *corrugata* appearance. On another specimen there are two extra presetal markings on one side; on the other side of xviii there are only two markings, in contact, both slightly sunk in a transverse depression, the male pore on the lateral marking.

The preclitellar genital markings are similar to the postclitellar markings and are usually close to or in the near vicinity of the spermathecal pores; on the posterior margins of vii and viii and the anterior margins of viii and ix; the markings immediately behind, in front of or slightly median to the spermathecal pores.

Genital markings are usually entirely lacking on the H and I specimens. One small specimen has a tiny, protuberant, and well-developed genital marking immediately behind each spermathecal pore. Another specimen has two pairs of tiny genital markings; presetal on viii and ix, each marking nearer to the midventral line than to the spermathecal pore, the markings of a pair separated by an interval about equal to 2–3 intersetal distances.

Genital markings of the other specimens are located as follows:

(A) On xviii: 4 presetal markings; one just median to each male pore tubercle and two near the midventral line, each marking just in front of *b*. On viii and ix, four pairs, presetal; one marking immediately posterior to each spermathecal-pore tubercle and another marking about 1 intersetal interval median to each spermathecal-pore tubercle.

(B) On xviii: 4 presetal markings located as on specimens A. On viii and ix; four pairs of presetal markings as on A and an additional marking, postsetal on ix, on the left side and in line with the presetal, median marking.

(C) On xviii: 4 markings; two just median to each male pore tubercle, one marking presetal and one postsetal. On vii and viii: 4 postsetal markings, one marking immediately anterior to (or anterior and very slightly median to) each spermathecal pore; and two presetal markings on viii, the markings slightly median to the spermathecal pores on 7/8.

(D) On xviii: 4 presetal markings located as on A. On viii and ix, four presetal markings: one marking about 1½ intersetal intervals median to the approximate site of each spermathecal pore. At the center of one of these markings there are visible six distinct minute pores. Originally there was a genital marking immediately behind each spermathecal pore, but the spermathecal pore tubercles and the associated markings had been removed in the previous dissection.

(E) The genital markings are tiny transversely oval areas on viii and ix; each area with a depressed center and a definite protuberant rim, less than 1 intersetal interval in width, slightly nearer to the intersegmental furrows than to the setae; one marking a trifle posterior to each spermathecal pore.

(F) Three presetal genital markings on xviii; one just median to each male pore tubercle and one just to the left of the midventral line, close to the setae and about in *ab*. On viii and ix there are four pairs of presetal markings as on A. On the grayish centers of each of the more median markings 6–9 pores are recognizable.

Internal anatomy.—(The internal organs had been removed from the anterior end of A, D, and two clitellate specimens of E or disarranged in previous dissections.) Septa 5/6–7/8 are thickly muscular; 8/9–9/10 lacking or 8/9 represented only by a ventral rudiment; 10/11–12/13 thickly muscular; 13/14 slightly strengthened.

On the esophagus just behind the gizzard there is either a lobed glandular collar or a rather slight ridgelike rudiment of the collar. The intestine begins in xv (21 specimens), with 15/16 (1 specimen), or in xvi (1 specimen). The intestinal caeca are simple, the ventral

margins incised in such a way as to mark off several rounded and stumpy or short, fingerlike lobes. Rarely there are also a few incisions of the dorsal margin. The typhlosole, a bladelike ridge, begins in the caecal segment.

There is a pair of hearts belonging to ix in 4 specimens; a single heart on the right side in 8 specimens, on the left side in 10 specimens. The last pair of hearts is in xiii (26 specimens). All hearts of ix–xiii pass into the ventral blood vessel. The hearts of x may be bound to the anterior face of 10/11 by connective tissue so that they are not readily recognizable.

The testis sacs of x and xi are unpaired and ventral (7 specimens), probably paired and ventral—no transverse connections between testicular masses of a segment recognizable (3 specimens, including one of the E specimens). The seminal vesicles may be small or medium-sized and vertical bodies, or large and in contact dorsally above the dorsal blood vessel, filling their segments. Primary ampullae may or may not be recognizable and when present may be more or less conical, protuberant, or sunk in a deep cleft in the dorsal margin of the ventral lamina, or merely demarcated from the ventral lamina by a circumferential constriction.

The spermathecal duct is stoutish, slightly bulbous toward the parietes, shorter than the ampulla, an ental portion usually invaginated into the ampulla. The diverticulum may be longer or shorter than the combined lengths of duct and ampulla. The diverticular stalk, which passes into the duct close to the parietes, is slender and glistening, nearly straight or bent entally into one to three tiny loops, the latter open or with the limbs in contact. The thicker but thin-walled seminal chamber, which is usually clearly marked off from the stalk, is elongate-ovoidal to ellipsoidal, approximately spheroidal, or somewhat pear-shaped. In the latter case the seminal chamber is not clearly marked off from the stalk. In specimen E the diverticulum is nearly three times as long as the combined lengths of duct and ampulla.

In segment xviii of specimens A–D and F the number of stalked glands is equal to the number of genital markings, including the male pore tubercles in the category of genital markings. Anteriorly the number of discrete glands may be less than the number of genital markings. Thus on the right side of segment ix in each of two specimens (A and B) two glands are enclosed in a common, connective tissue sheath; the entalmost portions of the stalks of the glands joined; passing ventrally toward the parietes the two stalks diverge, one passing to the genital marking immediately behind the spermathecal-pore tubercle, the other passing to the more median genital marking. (Also in viii and the left side of ix in specimen F.) A

similar condition is shown by Perrier in his pl. 4 (1872), fig. 68, where the stalk of the gland bifurcates near the parietes. "En arrière de ces deux premiers organes se voit une petite masse glandulaire, supportée par deux pédoncules." (See also Perrier's figure showing the genital markings.)

In specimens G there is a fairly conspicuous stalked gland projecting into the coelomic cavity dorsal to each genital marking, but a stalked gland to the male pore tubercle has not been noted. In specimens H there are stalked glands to the preclitellar genital markings when the latter are present. There may be a tiny stalked gland visible in the coelomic cavity near each prostatic duct. In some specimens a rudimentary gland may be found within the musculature in the vicinity of the prostatic duct. In other specimens, especially those in which the median portion of the ridge in the male parietal invagination is most compressed, no traces of glands or stalks were found.

Remarks.—There is some internal evidence to indicate that specimen C may be abnormal, but specimens A, B, D, and F appear to be normal.

Specimens G are certainly abnormal. Only one specimen has well-developed prostates (extending through xvii–xxi) and prostatic ducts (6 mm long, a middle portion thickly muscular). Each of 10 specimens lacks a prostate on one side, the prostate of the other side small and restricted to xviii. The prostatic ducts are present, even in absence of the prostates but are usually straight, the length varying from 3 to 6 mm. Other abnormalities have been noted in these worms especially in connection with the male deferent ducts. Two worms each have a pair of well-developed funnels in xii and a pair of seminal vesicles in xiii. No testes were found in xii in these specimens, but one has hypertrophied ovaries. In three worms the seminal vesicles are unusually large but are filled with parasitic masses. Each of two specimens has one male genital area that approximates more or less closely the condition characteristic of *corrugata.*

Specimens H are also almost certainly abnormal. The testis sacs of x and xi, which may be unpaired or paired, have little or no testicular coagulum but may be filled by the hypertrophied and undischarged testes and the male funnels. The seminal vesicles of x and xi are usually small, each vesicle provided with a primary ampulla, which is constricted off from the ventral lamina but not sunk therein, the ampulla often of about the same size as or only slightly smaller than the ventral lamina. In one small specimen, however (85 by 2½ mm), with genital markings, the seminal vesicles are large (relatively), in contact transversely over the dorsal blood

vessel, the primary ampullae small, more or less spheroidal and sunk into the dorsal margins of the ventral parts of the vesicles.

In one specimen the vasa pass posteriorly in the usual fashion, but the canal is unusually fine in part and nonexistent or at least unrecognizable in part. In another specimen each vas of a side can be traced from the prostate anteriorly to xv in a normal fashion. In the latter segment (on each side) the vas bifurcates into two discrete portions, which are separate through xiv and xiii. At the posterior face of 12/13 the separated portions again come into contact and then project through 12/13 slightly into xii. The terminus of the combined deferent ducts (of a side) in xii is club-shaped and firm. There are paired male funnels in the testis sacs of x and xi but no deferent ducts pass posteriorly from these funnels.

The spermathecal diverticula may not be differentiated into stalk and diverticulum, or the ental portion of the diverticulum may be widened but without the thin wall and large lumen of the seminal chamber. In only one specimen is there iridescent material in the seminal chambers. In this worm (the specimen with genital markings and large seminal vesicles) the elongated ellipsoidal seminal chamber is definitely marked off from a shorter stalk, but the spermathecal ducts are very short, almost rudimentary. The seminal chambers of other worms are filled with grayish or pinkish transluscent material or a watery fluid.

It is unfortunate that so few normal specimens of *P. robusta* have been available for study. Specimens G, however, from Szechwan, in spite of their abnormalities, can be referred with but little doubt to *robusta*. Specimens H from Szechwan, also abnormal, presented a greater difficulty because of the invaginate male pores. On finding two specimens that would otherwise have been referred to *robusta*, characterized by a male pore invagination (on one side only) of the *corrugata* type it seems necessary to regard worms H also as abnormal specimens of *robusta* though even more abnormal than specimens G. In this case the abnormality (invagination of the male pores) is such that it would ordinarily be considered not as an abnormality but as good evidence for specific distinctness.

The types of *P. löhri* must have been allowed to dry out at some time almost completely. The specimens are very hard, brittle, shrunken, wrinkled, and stuck together, the body wall transparent. After soaking in water for several days, followed by a very slight drying, it was possible to recognize under best optical conditions the genital markings and apertures. The internal organs of the undissected type are brittle, adherent to each other and to the membranes and the body wall. Nothing could be found, however, after careful examination of the internal organs to indicate that these specimens

are other than abnormally dwarfed individuals of *robusta*. In the aclitellate specimen and visible through the body wall are fairly large cysts, some of which are filled with pseudonavicellae spores. Possibly a heavy parasitic infestation during a juvenile stage was responsible for the dwarfing.

Ude's figure of a spermatheca (1932, p. 154, fig. 10) can scarcely be regarded as an illustration of any of the spermathecae (all of which are present) in the specimen of *P. lauta* now referred to *P. robusta*. The figure does show a condition that characterizes a single spermatheca of the holotype of *P. lauta* (=*P. aspergillum*). The spermatheca is abnormal, the seminal chamber swollen and distended by a transparent, watery fluid.

P. robusta is close to *P. aspergillum* from which it may be distinguished by the definitely smaller number of genital markings in the immediate vicinity of each male pore.

PHERETIMA SCHMARDAE (Horst)

1883. *Megascolex schmardae* HORST, Notes Leyden Mus., vol. 5, p. 194 (type locality: "Japan"; type in the Leyden Museum).

1892. *Perichaeta sumatrana* BEDDARD, Proc. Zool. Soc. London, 1892, p. 155 (Hongkong).

1899. *Perichaeta schmardae* var. *macrochaeta* MICHAELSEN, Zool. Jahrb. (Abt. Syst.), vol. 12, p. 227 (Kowloon near Hongkong).

1927. *Pheretima schmardae* MICHAELSEN, Boll. Lab. Zool. Portici, vol. 21, p. 84 (Macao).

1931. *Pheretima capensis* (part)+*P. schmardae* MICHAELSEN, Lingnan Sci. Journ., vol. 8, pp. 158, 160 (excluding from *capensis* all except *sumatrana* Beddard, 1892).

1931. *Pheretima* (*Ph.*) *schmardae*+*P. quadragenaria* MICHAELSEN, Peking Nat. Hist. Bull., vol. 5, pt. 3, p. 2.

1931. *Pheretima* (*Ph.*) *schmardae* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 7, p. 125 (Szechwan).

1933. *Pheretima schmardae* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 9, p. 277 (Chekiang and Hupei).

Material examined.—From the Hamburg Museum: 11 very soft clitellate specimens labeled "*Pheretima* (*Ph.*) *schmardae* Horst var. *Macrochaeta* (Mich.). China. Hongkong, Kowloon, Kraff l.d." From Dr. Graham: 1 clitellate specimen labeled "Suifu"; 3 clitellate specimens labeled "Between Kiating and Yachow, July 8–11, 1928."

External characteristics.—Length, 52–80 mm. Diameter, 2–4 mm.

The setae begin on ii, on which segment there is a complete circle. Some of the ventral setae of segments ii–v, vi, or vii are slightly enlarged. Posteriorly the setae are more closely spaced ventrally and laterally than dorsally. A midventral break in the setal circle when present is slight, usually lacking. A middorsal break of varying width is usually present. Setal numbers of the Szechwan specimens are as follows:

viii	xvii	xviii	xix	xx
29	----------	15	----------	----------
[1] 19	16	16	16	----------
26	17	[1] 9	17	47
31	22	16	22	53

[1] Indicates that there are gaps in the setal row where setae have probably fallen out.

On the Hamburg worms: viii/27–30, xviii/10–18.

The first dorsal pore (Szechwan specimens) is on 11/12 (1 specimen), on 12/13 (3 specimens). On the Hamburg specimens the first dorsal pore is either on 11/12 or 12/13.

The clitellum is annular, extending from 13/14 to 16/17; dorsal pores and intersegmental furrows lacking; setae present ventrally on xiv and xvi, possibly also on xv on some specimens.

The spermathecal apertures are minute, widely separated, on tiny transversely oval tubercles; two pairs, on 7/8–8/9. The spermathecal pore tubercles may be slightly protuberant or slightly depressed, in the latter case the appearance is superficially that of a transversely slitlike aperture to a spermathecal chamber.

The apertures of the copulatory chambers are round or transversely slitlike, the margins finely wrinkled. Each minute male pore is located on a small, smooth-surfaced, ovoidal to conical tubercle, which projects into the copulatory chamber lumen from the center of the dorsal wall.

Internal anatomy.—Septum 7/8 is thickly muscular or at least thicker than 5/6–6/7; 8/9–9/10 lacking.

The intestine begins in xv (8 specimens). The intestinal caeca are compound, glove-shaped, the dorsalmost secondary caecum the longest. The secondary caeca (4–9) are elongate, fingerlike, anteriorly directed, the length decreasing passing ventrally. On the esophagus just behind the gizzard is a low glandular collar.

Hearts of segment x were not found in any of the specimens. The single heart of ix is on the right side (4 specimens) or on the left side (4 specimens). The last pair of hearts is in xiii (8 specimens). All hearts of ix, xi–xiii pass into the ventral vessel.

The testis sacs of x and xi are unpaired and ventral. The seminal vesicles of xi and xii are fairly large, filling their segments and reaching into contact transversely over the dorsal blood vessels. Each vesicle is provided with a fairly large, more or less conical primary ampulla, the base of which is deeply constricted off from but sunk into the dorsal margin of the ventral lamina. The prostates extend through xvii–xx or xxi. The prostatic duct is 2½–4½ mm long. The entalmost portion of the duct, about 1 mm in length, is very slender.

The ectalmost portion of the duct, which passes into the center of the dorsal face of the copulatory chamber, is also slender but is firm, smooth, and glistening. This portion of the duct is covered over by connective tissue—on first opening the worm only the middle portion of the duct is visible. The thick part of the duct may be straight or bent into a C-shape. The copulatory chambers are large and project conspicuously into the coelomic cavity. The wall of a chamber is rather thick, so that the lumen is small. On the anterior as well as on the posterior face of each copulatory chamber is an ovoidal glandular mass. From each mass a short stalk passes to a thin-walled sac. The latter opens into the lumen of the copulatory chamber by a rather large pore. Within each sac is a single, circular, flat or convex genital marking to which the stalk of the gland can be traced.

The spermathecal duct is shorter than the ampulla, abruptly narrowed within the parietes ectal to the diverticular junction. When the spermathecal duct is carefully pulled out from the parietes after separating the longitudinal muscle fibers the tiny papilla on which the spermathecal pore is located is removed. The spermathecal duct does not appear to be clearly marked off from the ampulla, but this appearance is due to the fact that the ectal portion of the ampulla is pushed down around and bound to the ental end of the duct by connective tissue. If this tissue is cut and the ectal margin of the ampulla pushed up, the duct has a bulbous or almost spheroidal appearance. The stalk of the diverticulum is longer than the spermathecal duct and may be straight or closely and shortly zigzag-looped in an ental portion. The wider seminal chamber may be straight or also looped.

Remarks.—The Hamburg specimens are soft and in very poor condition. As a result of the post-mortem changes the tissues have been gelatinized into a very sticky condition; the body wall is transparent and the internal organs are gummed together. In this condition little of value can be noted with regard to the external characteristics or internal anatomy. Two specimens were completely ruined by attempting to study them while moist. Four other specimens were pinned out on boards and opened carefully by a middorsal incision. The worms were then allowed to dry slowly for an hour in a warm room. At the end of that time the tissues had dried out so that it was possible to separate the organs and manipulate the septa and other membranes and even to work out accurately the characteristics of the testis sacs. The setal numbers and the characteristics of the genital markings and male pore areas are the only points of importance that could not be satisfactorily studied on these dried specimens. Except for the characteristics just mentioned the Kowloon and the Szechwan specimens are alike.

No trace of the hearts of x was found nor any "commissural vessels" belonging to x. The asymmetrical pair that Chen (1931, p. 129) refers to x probably represents the commissures of ix.

There is also some confusion in Chen's account (1931) with regard to the copulatory chamber and its glandular appendages and especially the thin-walled sacs into which the glands open. Thus, on page 127 there are said to be "Two shallow pits on anterior and posterior sides of the chamber in which the lateral glands open," while on page 130 each lateral lobe is said to be connected by small cords with a "small pit at the lateral side of the chamber." There is no variation with respect to this character in any of the eight specimens dissected, the glands and the chambers to which their ducts pass being anterior and posterior, never lateral and median.

Beddard's *sumatrana*, 1892, is, in all probability, either *californica* or *schmardae*. The presence of large copulatory chambers rules out *californica*. Similarly, compound intestinal caeca would rule out *schmardae* were it not for the fact that all but the dorsalmost secondary caeca may be overlooked unless the gut (in a specimen dissected from the dorsal side as is usual) is rolled well over to one side or the other. The dorsalmost secondary caecum, failing this precaution, would then appear to be a simple caecum.

PHERETIMA SZECHUANENSIS Chen

1931. *Pheretima* (*Ph.*) *szechuanensis* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 7, p. 160 (type locality: Mount Tsing-Chen, Szechwan; type in the Museum of the Science Society of China).

Material examined.—From Dr. Graham: 1 clitellate specimen labeled "Suifu, 1,200–2,000 feet, October 1–November 1, 1928"; 2 clitellate specimens labeled "Suifu"; 3 clitellate specimens labeled "Near Haitaing, 6,000–8,000 feet, August 14, 1928"; 2 clitellate specimens labeled "Du Chiao, July 11–13, 1930."

External characteristics.—Length, 80–115 mm. Diameter, 3½ mm.

The setae begin on ii, on which segment there is a complete circle (with the exception of one specimen on which the dorsal setae are lacking from ii–vi). The ventral setae of ii–ix are enlarged, diminishing in size passing from *a* laterally. Setae *a–c* of these segments are nearly straight, with tips ornamented by transverse, infrequently broken rows of fine spines. A middorsal break of variable width is present in the setal circles, a midventral break slight or lacking. The setal numbers are as follows:

vii	viii	xvii	xviii	xix	xx	First dorsal pore
--------	17	18	16	21	----------	11/12
--------	----------	15	[1] 7	17	43	11/12
19	20	27	21	26	----------	11/12
12	13	24	18	25	52	[2] 5/6
14	15	18	18	21	56	[2] 5/6
14	15	13	11	15	----------	11/12
16	17	15	13	16	46	11/12

[1] Gaps present.
[2] See on dorsal pores below.

The first dorsal pore is on 11/12 (5 specimens). On two specimens there are porelike markings on 5/6–10/11. When the worms are bent the coelomic fluid oozes to the exterior through these pores (?), but the openings into the body cavity of the coelomic face of the parietes do not have quite the appearance of normal pores.

The clitellum is annular, extending from 13/14 to 16/17; dorsal pores and intersegmental furrows lacking; setae probably lacking on most of the specimens, but a few scattered setae present ventrally on xvi of one specimen.

The spermathecal apertures are minute, widely separated, on tiny tubercles on 6/7–8/9.

The male apertures are minute; in 5 specimens each pore is at the center of a small transversely oval tubercle. On one specimen each male pore is at the center of a very narrow elongate marking, extending anteroposteriorly nearly to 17/18 and 18/19. On the remaining specimens the male pores are on tiny pointed protuberances.

The genital markings are two pairs, each marking transversely oval, slightly larger than the oval male-pore tubercle, the center of each marking about in line with the male pore, one marking just in front of and another just behind the male-pore tubercle, an anterior or a posterior margin of a marking in contact with the tubercle (4 worms). On another specimen there are six pairs of these markings, one pair postsetal on xvii, another presetal on xviii and in addition an unpaired marking, two pairs postsetal on xviii, another presetal on xix, and one postsetal on xix. On the worm with elongated male-pore areas there is a pair of elongated genital markings, each with bluntly rounded ends, slightly crescentic in appearance with the concave side facing mesially, reaching anteroposteriorly to 17/18 and 18/19. On the remaining worms there are on xviii two pairs of genital markings, one presetal and one postsetal. The anterior, elongate-oval markings are just lateral to the male pores and extend anteriorly to 17/18 and posteriorly to just behind the setae. The posterior markings are smaller, almost circular, immediately behind the male pores.

Internal anatomy.—Septa 5/6–7/8 are thickened; 8/9 membranous but complete, bulged posteriorly into a funnel-shape by the gizzard; 10/11 membranous and apparently complete (1 specimen) present ventrally only in others and unrecognizable in the remainder; 11/12–12/13 membranous but slightly strengthened.

The origin of the intestine is variable. In one specimen the thick-walled, narrow, esophageal portion of the gut is continued into xxvi, the thin-walled, grayish, wider intestinal portion of the gut beginning abruptly with 26/27. In other specimens there is a more gradual transition from the esophageal to the intestinal portion of the gut, an abrupt widening such as is often present in xv, entirely lacking. The intestinal caeca are compound, glove-shaped, each caecum with 7–12 elongate, fingerlike, secondary caeca. The ventralmost secondary caecum is the longest, the dorsalmost the shortest.

The single heart of ix is on the left side (5 specimens) or on the right side (1 specimen). The last pair of hearts is in xiii. The hearts of ix–xiii all pass into the ventral vessel.

The testis sacs of x and xi are unpaired and ventral. The seminal vesicles are large, in contact transversely over the dorsal blood vessel. The prostates extend through xvii–xxi but may push 16/17 and 15/16 anteriorly. The prostatic duct is 7–10 mm long, bent into a hairpin loop, the ectal limb much thicker than the ental limb.

The spermathecal duct is stout, glistening, shorter than the ampulla, gradually narrowed in the parietes. The diverticulum passes into the anterior face of the duct close to or actually within the parietes and is composed of a slender, smooth, glistening, stalk portion with a narrow lumen and an ovoidal, spheroidal, or elongate-tubular, thin-walled, seminal chamber. The elongate-tubular seminal chamber was found only in a worm very heavily parasitized by coelomic Protozoa.

In the parietes in the vicinity of the ectal end of the prostate ducts there are glandular masses.

Remarks.—Three specimens were badly mutilated, each broken (though not quite through) in two places, one just anterior to the clitellum and one just posterior to the clitellum. A fourth specimen has several spiral abnormalities in the anterior region. The remaining specimens, as well as some of those just mentioned, are heavily parasitized by coelomic Protozoa and/or nematodes. In one of the unbroken specimens the reproductive organs are very poorly preserved, in particular the seminal vesicles and the testis sacs.

In this latter specimen the seminal vesicles of xi have the appearance of being contained within outgrowths of a testis sac, but the preservation is too poor to permit an exact determination of the rela-

tionships. In at least two specimens the presence of unpaired testis sacs has been definitely determined. In one specimen in which septum 10/11 is recognizable only in its ventral portion, the part on which the testis sac of x is located is invaginated into xi, while the portion of 11/12 on which the testis sac of xi is located is invaginated into xii. In one of the broken specimens the seminal vesicles of xi appear to extend anteriorly at the sides of the gizzard.

The only important difference between the account above and that of Chen is in the number of spermathecal setae on viii, 13–20 on the U. S. National Museum specimens, 22–30 on Chen's worms. Some of Chen's specimens are larger and longer than the National Museum specimens and have a slightly more extensive clitellum.

The genital markings are variable as regards number, location, shape, and size.

PHERETIMA TSCHILIENSIS Michaelsen

1903. *Pheretima asiatica* MICHAELSEN, Mitt. Naturhist. Mus. Hamburg, vol. 19, p. 11 (part) (Tibet).

1928. *Pheretima tschiliensis* MICHAELSEN, Arkiv för Zool. vol. 20, no. 2, p. 13 (type locality: 50 Chinese miles east of Hsuan-Hua-Hsien, Chihli; types in the Stockholm Museum).

1930. *Pheretima kiangsuensis* CHEN, Sci. Rep. Nat. Cent. Univ. Nanking, ser. B, vol. 1, p. 24 (type locality: ?; types ? Nanking and Soochow).

1931. *Pheretima asiatica* (part) + *P. tschiliensis* MICHAELSEN, Lingnan Sci. Journ., vol. 8, pp. 158, 160 (including part of or all the Tibetan forms of *asiatica*).

1931. *Pheretima* (*Ph.*) *tschiliensis* + *P. tibetana* MICHAELSEN, Peking Nat. Hist. Bull., vol. 5, pt. 3, pp. 2, 13 (type locality of *tibetana:* River Dracu, Tibet; types in the Hamburg Museum).

1931. *Pheretima tibetana* MICHAELSEN, Zool. Jahrb. (Abt. Syst.), vol. 61, p. 568.

1931. *Pheretima* (*Ph.*) *kiangsuensis* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 7, p. 119 (Szechwan; specimens in the Museum of the Science Society of China).

1933. *Pheretima tschiliensis* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol 9, p. 250 (Kiangsu, Chekiang, and Anhwei).

1935. *Pheretima tschiliensis* GATES, Smithsonian Misc. Coll., vol. 93, no. 3, p. 16.

THE FOLLOWING DOUBTFULLY PLACED IN SYNONYMY:

1933. *Pheretima yamadai* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 9, p. 255 (forms with simple intestinal caeca).

Material examined.—From the Hamburg Museum: 2 softened specimens (A) labeled "V 10579. *Pheretima tschiliensis* Mich. China, Prov. Chihli. Pro. Anderson leg. Michaelsen ded. 50 chin. Meilen östlich von Hsuan Hua Hsien"; 3 specimens (B) labeled "V 5890. *Pheretima asiatica* (Michlsn) Tibet. Koznakov Dracu" and "jetzt *Pheretima tibetana* Mich." From the U. S. National

Museum: 1 specimen (C) labeled "*Pheretima tschiliensis* (Mich.), Szechwan, China. Ident. by Y. Chen." From Dr. Graham: 1 clitellate specimen labeled "Near Mupin, 3,500–5,000 feet, July 1, 1929"; 1 clitellate specimen labeled "Near Kangshien, 1,400–1,800 feet, August 28, 1929"; 2 clitellate specimens labeled "Near Mupin, 1,300 feet, July 7, 1929"; 2 clitellate specimens labeled "Near Mupin, 7,000–13,000 feet, July 8, 1929"; 1 clitellate specimen labeled "Between Ningyuenfu and Den Shiang Uin, 6,000–8,100 feet, August 6–18, 1928"; 1 clitellate specimen "Chin-Chi-Shien, 3,500 feet, July 17, 1928"; 3 clitellate specimens labeled "Shin Kai Si at Mt. Omei, August 7–9, 1929"; 3 clitellate specimens labeled "South of Suifu on the Yunnan border, 6,000 feet, April 25, 1929 (secured by aboriginal collector for Dr. Graham)"; 1 aclitellate specimen labeled "Near Song Pan, 7,000–8,000 feet, July 12–13, 1924"; 1 aclitellate specimen labeled "Near Luting Kiao, 6,000 feet, August 9, 1923"; 1 aclitellate specimen labeled "Between Gin Keo Ho and Dawei, 1,300–5,000 feet, August 1–2"; 2 clitellate specimens labeled "Tatsienlu, 8,300 feet, July 16, 1930." Also 1 aclitellate specimen and 2 clitellate specimens (D) with no data.

External characteristics.—Length (of clitellate specimens only), 110–330 mm. Diameter, 6–13 mm. A grayish-blue to brownish pigmentation of the dorsum is recognizable on recent specimens; no pigmentation visible on older specimens.

The setae begin on ii, on which segment there is a complete circle, The setal circles are usually unbroken midventrally; rarely midventral gaps on a few of the postclitellar segments; slight midventral gaps on the preclitellar segments (1 specimen). The middorsal gaps, often lacking, are variable in width when present. The ventral setae of the preclitellar segments are slightly enlarged. The setal numbers are as follows:

vii	viii	xvii	xviii	xix	xx	Remarks
18	16	13	15	14	52	
17	19	16	15	17	63	
23	22	18	14	18	52	
16	16	16	12	13	54	
23	22	15	14	17	58	
25	27	18	13	20	63	
18	19	21	14	18	----------	
19	20	16	13	17	63	
21	22	19	13	13	63	
20	19	20	10	17	67	(1).
22	23	14	11	17	57	(1).
26	25	15	[2] 8	14	83	(1).
24	26	31	28	28	[2] 80	(2).
22	23	25	18	[4] 29	----------	Specimen C.
21	21	25	14	24	----------	Specimens A.
20	[2] 18	24	13	25	----------	
22	24	18	14	19	----------	Immature (?).
22	21	19	14	19	----------	Do.
19	20	21	19	22	----------	Do.
25	24	----------	14	----------	----------	Specimens B.[3]
23	24	----------	----------	----------	----------	
23	25	----------	----------	----------	----------	
26	25	16	[2] 2	16	67	Specimens D.
22	20	16	[2] 10	19	----------	
22	20	18	11	19	----------	

[1] Specimen with large numbers of parasitic bodies visible externally.
[2] Gaps in setal circle indicate that some setae have been lost.
[3] Large numbers of parasites in the coelomic cavities, the parasites not visible externally.
[4] Ventral setae of xix and some of the succeeding segments abnormally placed, possibly zigzagged; the setal row apparently doubled in spots.

The clitellum is annular, extending from 13/14 to 16/17. Intersegmental furrows and dorsal pores are lacking. Setae are usually lacking; on Chen's specimen there are circular rows of setal pits on xi–xvi but no setae are visible; on four specimens there are a few setae midventrally on xvi. The dorsal pores on 13/14 and 16/17 are functional.

The spermathecal pores are minute, widely separated; three pairs, on 6/7–8/9. Each pore is at the center of a tiny, circular to transversely oval, smooth area the margins of which are usually not clearly demarcated. The spermathecal pores are readily recognizable though minute owing to the presence of a tiny whitish rim around the margin of a pore. A spermathecal pore tubercle may be very slightly depressed into the body wall.

The apertures of the male-pore invaginations, are crescent-shaped, the concave side of the crescent facing midventrally. The apertures of softened specimens gape open so that a portion of the median wall of the invagination is visible. The lateral wall of the invagination is thin and without setae; the ventral margin of this wall forming a crescentic, lateral lip of the aperture of the invagination. On one specimen the invaginations are almost completely everted.

On the median wall of the invagination there is a lobulated ridge, which bears 2–6 setae. The minute male pore is on a smooth glistening porophore in the dorsalmost portion of the invagination. The shape of the porophore varies. In a majority of the specimens the porophore is an elongated, lateromesially compressed ridge, the ventral surface sloping dorsally toward the anterior and posterior ends. The portion of the ridge on which the male pore is located may be protuberant as a tiny knob. The porophores are shortened anteroposteriorly in one specimen, diagonally placed in another, almost transverse in another. In another specimen the porophores are shortened and more protuberant, rather conical, and somewhat penislike in appearance. The genital markings on the median wall of the invagination are variable as to size, number, and location:

I. One small, transversely oval, protuberant, presetal disk; the central portion grayish and translucent; the margin opaque and whitish. 5 specimens.

II. Two oval disks, one presetal and one postsetal. 1 specimen.

III. As in I but the disk hypertrophied, about 6 intersetal intervals wide transversely; the median ridge dislocated posteriorly, crowded against the posterior wall and apparently without setae. 3 specimens.

IV. A transversely oval presetal disk as in I and in additional one or more circular markings as in V.

V. Genital markings tiny, circular in outline, usually protuberant. Two presetal markings, 1 specimen. Two presetal and two postsetal markings, 2 specimens (on one of these specimens the latter markings unusually deep in the invagination and in contact with the male porophore). One presetal and one postsetal marking, 1 specimen.

The apertures of the male pore invaginations of specimens D gape open widely. On the median wall of the invagination is a large, presetal, transversely oval genital marking that is 4–5 intersetal intervals wide transversely. In the clitellate specimens this marking has grown posteriorly through the region on which the ridge should be located. Setae appear to be lacking in the invaginations of the clitellate specimens. The male porophore is in the dorsalmost portion of the invagination and varies from a shortly conical penislike tubercle with a bluntly rounded ventral end to an elongate lateromesially compressed ridge. On the median wall of the invagination between the oval tubercle and the male porophore there is, in each of the specimens, a smooth, glistening, tripartite, butterfly-shaped area. The middle portion representing the body is slightly more protuberant than the presetal or postsetal portions that represent the spread wings. On the aclitellate specimen the male porophores, the butterfly-shaped areas, and the oval disks are delimited, but the parietal invagination is represented only by a slight crescentic

groove the horns of which pass mesially just beyond the butterfly marking. Just lateral to the groove is a tiny rudiment of the crescentic lip of the adult invagination.

Just behind each spermathecal pore there is usually a genital marking. This marking may be transversely oval or crescentic and with the concave margin in contact with or near to the posterior margin of the spermathecal pore tubercle. The crescentic markings may be quite protuberant and constricted slightly so as to produce a stalked appearance. In place of or in addition to the markings just mentioned there may be small circular genital markings, each of which as well as the previous markings has a grayish, translucent, central portion and an opaque rim. The extra markings may be on the anteriormost margins or vii–ix, the posteriormost margins of vi–viii (rarely) or nearer to the setae than to intersegmental furrows; one marking just in front of a spermathecal pore or just median to a spermathecal pore or 2–5 intersetal intervals median to a spermathecal pore. Preclitellar genital markings are lacking on specimens D.

Internal anatomy.—Septa 5/6–7/8 are thickly muscular; 8/9–9/10 lacking; some or all of septa 10/11–13/14 thickly muscular.

On the esophagus just behind the gizzard there is visible in many of the specimens a slight glandular collar. The intestine begins in xv (15 specimens); in one specimen the gut slender through segments xv–xvii, widening gradually in xviii–xx. The intestinal caeca are simple; the ventral margins incised, the depth of the incisions variable, usually deeper posteriorly and less readily visible or lacking anteriorly.

A pair of commissures belonging to ix is present in three specimens, in two of which one commissure is quite definitely smaller than the other; a single commissure on the left side of ix (6 specimens), on the right side (4 specimens). The last pair of hearts is in xiii (16 specimens). The hearts of x are fairly large but are more or less closely bound to the anterior face of 10/11. All hearts of ix–xiii pass into the ventral vessel.

The testis sacs of x and xi are unpaired and ventral; the anterior sac with a bilobed ventral margin. The seminal vesicles are fairly large, filling segments xi and xii and in contact transversely above the dorsal blood vessel. Usually each vesicle is provided with a primary ampulla, the base of which may be more or less deeply sunk into the dorsal margin of the ventral lamina. In some of the specimens there are paired, stalked pseudovesicles in xiii. The prostates extend through some or all of segments xvi–xx. The prostatic ducts are 6–20 mm long, bent into hairpin-shaped loops, the ectal limb of each loop much thicker than the ental limb.

The spermathecal duct is stoutish, usually slightly shorter than the ampulla from which it is more or less clearly demarcated. Near the parietes the duct is swollen and has a more or less strongly marked, bulbous appearance. Removal of the longitudinal musculature discloses in the parietes a rather thick, firm column. This column is usually removed when the spermathecal duct is pulled out from the parietes, the spermathecal pore tubercle on the ventral face of the column. When the spermathecal duct is pulled out from the parietes of softened specimens the column is not removed, but a very slender, conical portion of the spermathecal duct is pulled out from the center of the column. At the end of the conical portion of the duct is the spermathecal pore surrounded by the tiny whitish ring of tissue previously mentioned. In this case a circular hole with a smooth margin is left in the spermathecal pore tubercle. The diverticulum passes into the median face of the duct close to the parietes and comprises a smooth, glistening stalk with a narrow lumen and a thin-walled seminal chamber with a wider lumen. The seminal chamber is usually looped back and forth in a regularly zigzag fashion; the limbs of the loops are short and in apposition but may be straight or nearly so, twisted variously or loosely and irregularly looped. The diverticulum (in the looped condition) is about as long as or longer than the combined lengths of duct and ampulla. The length of the diverticular stalk varies considerably.

In the parietes just behind each spermathecal duct there is usually visible a mass of glandular tissue slightly protuberant into the coelomic cavity and forming a sort of U-shaped half-collar on the posterior face of the ectal end of the spermathecal duct. Some of the stalks or ducts from this glandular mass may be firmly attached to the duct but do not appear to pass into the duct. In xviii, on the parietes, anterior or median or posterior to the ectal end of the prostatic duct there is usually visible glandular tissue in one or more discrete masses with ducts passing to the genital markings in the male pore invagination. The glandular masses are usually flattened and not conspicuously protuberant into the coelomic cavity.

Remarks.—A number of the specimens, including the largest worm (330 by 13 mm) and the types of *P. tibetana*, are heavily parasitized. Some of these parasitized worms are obviously abnormal. Possibly the abnormalities have developed as a result of the parasitic infection. Among the abnormalities noted are the following: Rudimentary spermathecae, spermathecal duct unusually long (much longer than the ampulla), seminal chamber very loosely looped or with but one or two loops or practically straight. Possibly the absence of genital markings in some of the parasitized specimens and some of the

rather unusual variation in the setal numbers are also to be explained as the result of parasitic infection.

So many of the specimens are parasitized or show evidence of previous infestation or are abnormal that the determination of the normal range of variation of important characteristics has not been possible. Whenever normal specimens are available the variation in the setal numbers and the location and numbers of the genital markings should be recorded.

The male parietal invaginations of *P. tschiliensis* are very similar to those of *P. praepinguis*. The two species are distinguished from each other by characteristics of structures at the ectal end of the spermathecal ducts. There is evidence to indicate that the development of the spermathecal apparatus may be affected in various ways as the result of the presence in the worms of large numbers of parasites. If the parasitic influence is able to inhibit the development of the spermathecal pore invaginations in *P. praepinguis*, such abnormal specimens may be very difficult to distinguish from *P. tschiliensis*.

Specimens of *P. tibetana* (= *P. tschiliensis*) were originally regarded as conspecific with the Tientsin specimens of *P. asiatica* (Michaelsen, 1903, p. 11). The distinctions that Michaelsen later made between *P. asiatica* and *P. tibetana* do not appear to be of importance.

Specimens of *P. asiatica* have not been available for examination. The species is inadequately characterized. *P. tibetana* and *P. asiatica* may be synonymous as Michaelsen originally thought, or *asiatica* may be a synonym of *P. guillelmi*.

PHERETIMA TUBERCULATA Gates

1935. *Pheretima tuberculata* GATES, Smithsonian Misc. Coll., vol. 93, no. 3, p. 18 (type locality: Suifu, Szechwan; types in the U. S. National Museum).

1936. *Pheretima tuberculata* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 11, p. 302 (after examination of type).

Material examined.—From Dr. Graham: 1 clitellate specimen labeled "Suifu, 1,000 feet, April–May 1925"; 1 partially clitellate specimen and 3 clitellate specimens labeled "Suifu, 1929"; 1 aclitellate specimen and 1 clitellate specimen labeled "Mupin, 3,500–5,000 feet, July 1, 1929."

External characteristics.—Length, 80–110 mm. Diameter, 3–5 mm.

The setae begin on ii, on which segment there is a complete circle. A midventral gap in the setal circle is usually lacking, when present slight; a middorsal gap also usually lacking, when present variable though never very wide. The setal numbers are as follows:

vi	vii	xvii	xviii	xix	xx	First dorsal pore
10	11	17	10	19	41	10/11
9	10	18	12	18	40	[1] 10/11
9	9	17	12	17	40	[1] 11/12
10	10	16	11	18	----------	10/11
10	14	17	12	18	51	10/11
10	13	19	13	19	53	10/11
10	10	17	12	20	----------	10/11

[1] A porelike marking on 9/10 or 10/11.

The first dorsal pore is usually on 10/11.

The clitellum is annular, extending from 13/14 nearly to 16/17; intersegmental furrows and dorsal pores lacking; no setae visible. On two specimens the clitellum does not reach to 13/14.

The spermathecal pores are minute, widely separated; three pairs on 5/6–7/8.

The male pores are minute, each pore at the center of a very small, indistinctly demarcated, oval area in the setal circle of xviii. On this male pore area there are several tiny, slightly protuberant, circular tubercles. There are usually two of these tubercles just median to the male pore, one presetal and one postsetal, and a third lateral to the male pore and either presetal or postsetal. In addition there may be 1–3 further tubercles crowded in between the male pore and the lateral or median tubercles.

Anterior to each spermathecal pore and on the posteriormost margin of the segment is a tiny circular tubercle at the center of which there is a pore or porelike depression. This pore may be mistaken for a spermathecal pore; it is often much easier to see than the spermathecal pore. The spermathecal pore can be distinguished by its posterior location and recognized by the very delicate iridescence of the margin of the pore, an appearance that is entirely lacking around the pore of the tubercle. (If the spermathecal duct is carefully pulled out from the body wall the spermathecal pore is removed but not the tubercle.) Four specimens have no further genital markings. A fifth specimen has a pair of tubercles on viii, presetal in position, nearer to the setae than to the intersegmental furrow and to the midventral line than to the spermathecal pore, while on the left side of vii and in line with the left tubercle of viii there is a single presetal tubercle.

A sixth specimen has a pair of tubercles on xviii close to the midventral line and to the intersegmental furrow 17/18 and a single tubercle on xix close to 18/19 and just to the left of the midventral line. This specimen also has a single presetal tubercle on viii close to the midventral line and the setae. Another specimen, which is

not included in the account above but which probably belongs to this species, has several spiral abnormalities on the anterior segments. On this worm there are paired presetal tubercles on vi–vii or v–vi, depending on which side one counts the intersegmental furrows. (On this same specimen the male-pore area on which the tubercles are seated is clearly marked off by a slight but evident circumferential furrow.)

Internal anatomy.—None of the septa are thickly muscular, though 5/6–7/8 and some or all of 10/11–12/13 are strengthened and with muscular fibres; 8/9–9/10 lacking.

The intestine begins in xv. The intestinal caeca are compound, glove-shaped, with 3–5 fingerlike, anteriorly directed, secondary diverticula. The dorsalmost diverticulum is the longest, and attached to its ventral margin are 3–6 anteriorly or ventrally directed tertiary diverticula.

There is a pair of hearts belonging to ix (1 specimen), a single heart on the right side (2 specimens) or on the left side (2 specimens). The last pair of hearts is in xiii (5 specimens). All hearts of ix–xiii pass into the ventral blood vessel. The hearts of x are held by connective tissue against 10/11.

The testis sacs of x and xi are unpaired and ventral. The seminal vesicles are fairly large, filling segments xi and xii, those of a segment in contact transversely over the dorsal blood vessel. The prostates extend through xvii–xxi or xxii. The prostatic duct is 2–3 mm long, softish, a middle portion thicker than the rest, bent into an S- or W-shape or almost straight. There is a pair of rudimentary pseudovesicles on the posterior face of 12/13 and a still smaller pair on the posterior face of 13/14, each pseudovesicle club-shaped.

The spermathecal duct is short, narrowed gradually in the parietes, and not sharply demarcated from the longer ampulla. The diverticulum, which passes into the median face of the duct close to the parietes, is longer than the combined lengths of duct and ampulla and comprises a slender, smooth and glistening, firm stalk, which is longer than the spermathecal duct, and a thinner-walled ental portion, which is looped in a regularly zigzag fashion with the loops short and all in the same plane. The diverticulum may be almost straight with a slight suggestion of a spheroidal seminal chamber at the ental end.

Connected with each tubercle or genital marking is a stalked gland, the gland spheroidal to ovoidal, usually quite small, the stalk much longer, smooth, glistening and tough, erect in the coelomic cavity. The stalks of the glands passing to the tubercles just in front of the spermathecal pores may be much shortened and very slender or about the same size and length as those of the other tubercles.

Remarks.—*P. tuberculata* is distinguished from sexthecal Chinese species of *Pheretima* with spermathecal pores on 5/6–7/8 by the compound, glove-shaped, intestinal caeca.

Chen (1936, p. 303) gives a figure of an intestinal caecum that appears to be only the dorsalmost secondary caecum.

PHERETIMA VULGARIS Chen

1930. *Pheretima vulgaris* CHEN, Sci. Rep. Nat. Centr. Univ. Nanking, ser. B, vol. 1, p. 12 (part) (type locality: ?; types: ?; excluding forms with male pores in parietal invaginations).

1931. *Pheretima kiangensis* MICHAELSEN, Zool. Jahrb. (Abt. Syst.), vol. 61, p. 558 (part) (excluding quadrithecal forms with superficial spermathecal pores; Soochow).

1931. *Pheretima* (*Ph.*) *kiangensis* MICHAELSEN, Peking Nat. Hist. Bull., vol. 5, pt. 3, pp. 3, 21 (part) (excluding quadrithecal forms with superficial spermathecal pores).

1933. *Pheretima guillelmi* CHEN, Contr. Biol. Lab. Sci. Soc. China, zool. ser., vol. 9, p. 249 (part) (excluding synonymy and distribution of forms with male pores in parietal invaginations).

1933. *Pheretima vulgaris* FANG, Sinensia, vol. 3, no. 7, p. 179 (part) (specimens from Ichang).

1935. *Pheretima vulgaris* GATES, Smithsonian Misc. Coll., vol. 93, no. 3, p. 19.

Material examined.—From the Hamburg Museum: 6 clitellate specimens from a tube labeled "*Pheretima pingi* Steph. Soochow Biol. station leg."; 1 aclitellate specimen labeled "*Pheretima* (*Ph.*) *kiangensis* Mich. (=*Ph. kiangsuensis* Chen). *China.* Soochow Biol. station, Soochow."

External characteristics.—Length, to 220 mm. Diameter, to 8 mm.

The setae begin on ii, on which segment there is a complete circle. The setae are small, closely and regularly spaced. The setal numbers are as follows:

vii	viii	xvii	xviii	xix	xx
26	26	17	15	20	64
21	21	19	12	18	65
28	28	27	17	24	78
23	24	19	14	19	76
21	20	18	12	16	----------
19	21	15	11	15	[1] 66
14	14	18	17	19	([2])

[1] Aclitellate specimen. [2] Abnormal specimen.

The first dorsal pore is on 12/13, but on two specimens there is a nonfunctional porelike marking on 11/12.

The clitellum is annular, extending from 13/14 to 16/17; intersegmental furrows lacking; functional dorsal pores present on one specimen, nonfunctional rudiments of dorsal pores visible on an-

other specimen; setae apparently lacking on four specimens, although setal pits may be visible ventrally, setae present ventrally on xiv (1 seta) and xvi (6 setae) on one specimen.

The secondary spermathecal apertures are wide slits; three pairs, on 6/7–8/9. Each pore is 2–3 intersetal intervals wide transversely. The anterior margin of the pore is slightly protuberant and minutely lobulated. The posterior margin may or may not be protuberant and lobulated.

One of the specimens has a pair of female pores on xiv instead of a single pore.

The apertures of the copulatory chambers are longitudinal slits, the median margin of the slit minutely lobulated, the lateral margin smooth and firm. The copulatory chambers of four of the specimens are everted as conspicuously protuberant club-shaped bodies, thickest ventrally, narrowing gradually passing dorsally. The narrow neck, a short portion almost at the level of the ventrum, is firm, smooth, or with several very slight circumferential furrows. Ventral to the neck portion the protuberance is softer, and the surface is cross-hatched by numerous furrows. On the posterior face, close to the neck, is a single genital marking, circular or oval. On the flat ventral surface is a crescentic groove or slit, its concave side facing mesially. The slit opens into a lumen, which is crescentic in section and which extends within the protuberance nearly to or slightly into the neck. On the median wall of this lumen there are three markings, two oval, one circular. One of the oval markings is flat, without a raised margin and with a tiny, whitish, conical protuberance, at the pointed end of which is the minute male pore. A peripheral portion of each of the other markings is slightly raised and rimlike, and on this rim is a fine groove or furrow, circular or oval in outline according to the shape of the marking. There is no groove on the male pore area. Presumably the copulatory chambers are only partially everted. Complete eversion then would obliterate the lumen and bring the markings therein onto the ventral face of the porophore.

There are no external genital markings.

Internal anatomy.—Septa 5/6–7/8 are muscular; 8/9 represented by a membranous ventral rudiment; 9/10 lacking; 10/11–12/13 muscular; 13/14–14/15 strengthened but translucent.

There is a glandular collar of grayish, finely granular appearance on the esophagus just behind the gizzard. The intestine begins in xv (4 specimens). The intestinal caeca are simple; without marginal incisions in one specimen, slightly constricted by the septa in three specimens, with numerous lobulations of the ventral margin in the abnormal specimen. The typhlosole begins just behind the caeca.

The single heart of ix is on the left side (2 specimens) or the right side (3 specimens). The hearts of x are large and filled with blood. The last pair of hearts is in xiii (4 specimens). All hearts of ix–xiii pass into the ventral blood vessel.

The testis sac of x is U-shaped. The dorsal ends of the limbs of the U reach to or nearly to the dorsal blood vessel. The testicular coagulum within the sac apparently reaches dorsally in only one specimen. However, when the sacs of the other three specimens were cut open a thin layer of testicular coagulum was found on the anterior face of each heart. The testis sac of xi is also U-shaped in three specimens, the hearts and seminal vesicles of xi contained within the limbs of the sac, the vesicles and hearts embedded in testicular coagulum. In the fourth specimen the dorsal ends of the limbs of the U have fused above the gut so that a portion of the dorsal blood vessel is within the sac and surrounded by testicular coagulum. The testis sac of xi in this specimen is accordingly annular.

The seminal vesicles of xii are in contact transversely above the dorsal blood vessel. No primary ampullae are recognizable on the vesicles of xii, but each vesicle of xi is provided with a definite, more or less conical ampulla.

The prostates extend through some or all of segments xvii–xxi, each prostate cut up into 15–25 or more elongate-fingerlike lobes. The prostatic duct is 6–8 mm long, bent into a hairpin loop, the ectal limb of the loop much thicker than the ental limb. In three specimens the prostatic duct passes directly into the parietes, and there is no trace whatever within the coelomic cavity of copulatory chambers. In the retracted condition the copulatory chambers are club-shaped, narrowed ectally, but this is not at first evident as each chamber is bent over onto the parietes laterally while portions of the chamber are covered over by muscular bands, connective tissue, and glandular masses. The prostatic duct passes into the mesial face of the chamber near the ental end, but this also is obvious only after removal of connective tissue. The tracing of the prostatic duct and the gland stalks through the neck of the everted chamber to the markings is easy, as there is little connective tissue. The glands connected with circular genital markings are smaller than those connected with oval markings.

The coelomic portion of the spermathecal duct is pinkish, short, thick, rather bulbous, and with a smooth surface. The diverticulum passes into the median face of the duct. Ectal to this junction the duct is narrowed, the slender portion within the lateral wall of the spermathecal chamber. The diverticular stalk is always longer than the coelomic portion of the spermathecal duct and like the latter

is firm, smooth, and pinkish. The seminal chamber is elongate and looped, the looping usually (completely or in part) of a short, regularly zigzagged type. The spermathecal chamber projects conspicuously into the coelomic cavity, but the junction of the chamber and the bulbous portion of the spermathecal duct is covered over by connective tissue so that the chamber at first appears to be merely a thicker ventral portion of the duct. The chamber does not, however, have the smooth pinkish appearance of the bulbous portion of the duct. Within the chamber are two or three genital markings, round or oval and similar to those in the copulatory chamber. The wall is cross-hatched by furrows producing a warty appearance very similar to that within the copulatory chambers. The minute, primary spermathecal pore is located at the apex of a tiny, glistening, conical protuberance. The margin of this protuberance is not definitely demarcated as is the margin of a genital marking. The stalks of the genital marking glands are not as a rule confined to the wall of the spermathecal chamber but project slightly from the surface of the chamber, holding the glands erect in the coelomic cavity. All spermathecal chambers of each specimen are completely retracted.

Remarks.—The aclitellate specimen is 125 mm long; maximum diameter, nearly 4 mm. The clitellar segments are fully setigerous and without trace of clitellar glandularity. The spermathecal apertures are open and transversely oval; through each aperture a genital marking is visible, the marking in the lateral part of the spermathecal chamber. The partially everted copulatory chambers are as on the clitellate specimens except that there are two round genital markings in contact and near the neck. The genital markings, in the spermathecal as well as in the copulatory chambers, are fully developed and similar in appearance to those of clitellate specimens. The conical protuberance on which the minute spermathecal pore is located is not so large as in adult specimens. The male pore area is also not quite so large as in clitellate specimens, though the minute male pore is recognizable.

The seminal vesicles are approximately of adult size. The testis sacs are both U-shaped. The testicular coagulum extends in the sac of x only halfway up the limbs of the U. There is a very thin layer of testicular coagulum in the sac of xi partially surrounding each seminal vesicle. The prostates and prostatic ducts are nearly adult size. The spermathecal chambers are well developed and project conspicuously into the coelomic cavity. The spermathecal ducts are apparently fully formed. The ampullae are small and empty. The diverticula are probably also fully formed, but the seminal chambers are transparent. The glands on the spermathecal chambers and in the prostatic region are very small.

The account above (normal forms) differs somewhat from that of Chen, especially with respect to the copulatory chambers, testis sacs, and male deferent ducts. The everted copulatory chambers of the Hamburg specimens are club-shaped but with the narrowed portion of the everted body nearest the parietes, a reversal of the condition figured by Chen. The testis sacs of x and xi of the Hamburg specimens are U-shaped. Chen's description of the testis sacs is, however, not clear, so that an adequate basis for comparison is not available. In the Hamburg specimens the two male deferent ducts of a side come into contact in segment xii, whereas in Chen's specimens the vasa deferentia of a side pass posteriorly into xviii independently of each other. The differences just mentioned appear to be rather unimportant and insufficient justification for the erection of a new species, especially in view of the similarities of the copulatory and spermathecal chambers. The Hamburg specimens have accordingly been referred to *P. vulgaris.*

One of the specimens of "*pingi*" is abnormal but probably referable to *vulgaris.* The spermathecal pores are transverse, wide slits with slightly elevated and minutely lobulated anterior and posterior margins. The pores do not open into deep pits but into shallow depressions. One of these depressions is deeper than the others and contains a single circular genital marking. The minute primary spermathecal pores are not visible and could not be found by tracing the spermathecal duct through the parietes. The external spermathecal apertures are like those of *vulgaris* except that they do not open into deeply invaginated spermathecal chambers. The development of the chambers appears to have been suddenly stopped before the invagination extended through the body wall, or in the case of some of the pores before the invagination had penetrated to the level of the longitudinal muscle layer.

The male porophores are conspicuously protuberant and slenderly columnar bodies. There are one or two genital markings at the ventral end of a porophore, but the markings are very vaguely outlined and do not appear to be normal. The male pores were not found. There are several setae on the median face of each porophore.

The testis sacs of x and xi are unpaired and ventral, seminal vesicles of xi excluded. The left anterior vesicle is much firmer than the other vesicle and projects conspicuously into the gizzard segments through an oval aperture in 10/11 at the level of the dorsal blood vessel.

The spermathecal duct is rather slender, of about the same length as the ampulla, pinkish but rather soft. The diverticular stalk is about as long as the spermathecal duct or slightly shorter.

The single preclitellar stalked gland passes through the parietes to the genital marking previously mentioned. The glands in the prostatic region are rudimentary.

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The abnormalities of this worm may have been brought about as the result of the presence of large numbers of parasites. In the postclitellar portion of the worm there are many gregarinoid cysts on the body wall, fairly regularly distributed throughout the whole of this portion of the worm. There are also a few cysts on the dorsal face of the gut. In addition, there are nematodes in the coelomic cavities, throughout the entire length of the worm.

Fang (1933, p. 179) refers three worms "apparently without clitellum" from Nan-hu to *P. vulgaris.* One of these specimens, labeled "*P. vulgaris* Chen. Ichang, Hupeh, 1929" has been available for examination. The specimen is quite obviously aclitellate. The worm is characterized by large, club-shaped, copulatory chambers, a U-shaped testis sac belonging to x and spermathecal invaginations into the coelomic cavities as in *P. vulgaris.* Other sex organs are more or less rudimentary.

Fang also states that "some individuals collected from Peiping by Mr. C. J. Shen are referable to this species," i. e., *P. vulgaris.* Chen's species, however, comprised two distinct forms. Fang does not indicate which of these forms is involved, and accordingly the record from Peiping cannot be accepted.

PHERETIMA species, 1

Material examined.—From Dr. Graham: 2 aclitellate specimens labeled "Mt. Omei, 6,000 feet, August 1922"; 2 aclitellate specimens labeled "Shin Kao Si, Mt. Omei, 4,400 feet, August 25–26, 1924."

External characteristics.—Length, 242–357 mm. Diameter, 11–13 mm.

The setae begin on ii, on which segment there is a complete circle. There is no definite midventral gap in the setal circles; the middorsal gaps are of variable width. Setal numbers are as follows:

vii	viii	xvii	xviii	xix	xx
25	27	----------	30	----------	----------
25	26	----------	25	----------	----------
25	26	27–30	22	24–30	ca. 83
23	26	----------	25	----------	----------

The first dorsal pore is on 11/12 (1 specimen) or 12/13 (3 specimens).

There is no indication of the development of clitellar glandularity on any of the specimens. A single female pore can be recognized on xiv on one specimen.

The spermathecal pores are minute, on tiny tubercles or areas of especial smoothness; three pairs on 6/7–8/9.

In the setal circle of xviii on each side there is visible a small transversely oval area. Each of these areas is demarcated laterally by a slight, rather crescentic furrow, the concave side of the crescent facing midventrally. Just lateral to this furrow on one specimen is a tiny rudiment of a cresentic lip. On the lateralmost portion of the oval area there is visible a minute rudiment of the male pore (confirmed by dissection). On each male pore area (1 specimen) there are visible with high magnification and brilliant illumination two tiny spots somewhat median to the male-pore rudiment. These spots appear to be the rudiments of genital markings. Just anterior to the lateralmost 2 or 3 male setae on each side is a transversely oval genital marking.

Internal anatomy.—Septum 4/5 is thin; 5/6–7/8 thickly muscular; 8/9–9/10 lacking; 10/11–13/14 muscular to thickly muscular; 14/15 slightly muscular; 15/16 and several succeeding septa are thickened but membranous.

The intestinal caeca are simple, extending from xxvii into xxi–xxiii; the ventral margins incised, the ventral lobes rounded or fingerlike but short and stumpy.

The testis sacs of x and xi are unpaired and ventral. The seminal vesicles of xi and xii are medium-sized, anteroposteriorly flattened, vertical bodies. In xiii there is a pair of fairly large pseudovesicles. The prostatic duct is 4–5 mm long, bent into a C- or U-shape. The duct is not narrowed prior to entrance into the parietes but on the contrary has a rather bulbous appearance in the dorsal portion of the body wall. While the longitudinal muscle fibers were being removed the prostatic duct was accidentally broken off. The broken ends are not irregular and jagged but smooth and regular. At the ventral end of the ental portion there is a deep, smooth-surfaced and glistening, cuplike socket. Attached to a middorsal point within the socket is a very slender but firm cord. The dorsal end of the ectal portion of the duct is also smooth and glistening, ball-shaped. At the center of the dorsal surface is a pore opening into a lumen from which the slender cord has been pulled out. The ectal portion of the duct narrows gradually in the outer portion of the body wall but can be readily traced for most of the distance, as it remains firm and has a smooth, glistening surface. The prostatic duct of the other side of the same worm was then broken off revealing a similar ball-and-socket joint.

The spermathecae are rudimentary, just projecting from the parietes into the coelomic cavity; the diverticulum, a slender, fingerlike body; duct and ampulla not differentiated. Pulling the spermatheca out of the parietes after separating the fibers of the longitudinal muscle layer leaves a rather wide, transversely oval aperture with a smooth margin in the epidermis.

Remarks.—Some of the preclitellar, ventral setae are enlarged and modified; 0.7–1.0 mm in length, the ectal tip ornamented with circles of very fine teeth.

In spite of their size the worms just described are not sufficiently mature to enable specific identification. The crescentic furrow and lateral lip at the margin of the male pore area probably represent an early stage in the formation of the type of male parietal invagination that characterizes *P. praepinguis.*

No preclitellar genital markings were observed in the first examination, but after completion of the study of the holotype of *P. praepinguis* the worms were reexamined and a tiny area of peculiar appearance was noted just anterior to each spermathecal pore. This area may possibly represent the rudiment of the genital marking on the anterior face of the spermathecal invagination of *praepinguis.*

One of the prostatic ducts of the type of *praepinguis* was purposely broken off by a quick jerk, thereby revealing a "joint" somewhat similar to that described above except that both ball-and-socket portions are more flattened out.

Numbers of parasites (nematodes and Protozoa) were found in the coelomic cavities of the two aclitellate specimens that were opened.

PHERETIMA species, 2

Material examined.—From the U. S. National Museum: 1 clitellate specimen labeled "*Pheretima szechuanensis* Chen, paratype, Y Chen."

Remarks.—On each male pore area of xviii are tiny rudiments of three markings, two of which are toward the median margin with one presetal and one postsetal, while the third is toward the lateral margin and probably represents the rudiment of a male pore disk. Just lateral to the male pore area is a rudiment of a lateral lip such as is associated with the type of parietal invagination found in *P. tschiliensis* and related forms.

The intestinal caeca are simple, long, and slender, with slight incisions of the ventral margin.

The spermathecae are rudimentary.

The worm is quite obviously not *P. szechuanensis.*

PHERETIMA species, 3

1927. *Perichaeta hupehensis* Gee, Boring, and Wu, Lingnaam Agr. Rev., vol. 4, p. 1.

According to Gee, Boring, and Wu (1927), "the common Soochow worm," which they identified as "*Perichaeta hupehensis*," has two, three, or four pairs of spermathecal pores though the "normal number is three" on 6/7–8/9 (p. 1). The large apertures on xviii, which

are said to be "very evident after the worm has been killed" (p. 1), or "conspicuous slits" (p. 7) must be apertures of copulatory chambers or openings into parietal invaginations. These structures indicate that the "common Soochow worm" is probably not *P. hupeiensis*, a probability that becomes a certainty with the absence of septa 8/9–9/10. The variation in the number of spermathecal pores may be taken as an indication that the "Soochow worm" is possibly at least three distinct species, none of which can be referred to *hupeiensis*.

Two other points may be mentioned in connection with the paper by Gee, Boring, and Wu: (1) "In the Soochow *Perichaeta* the ventral vessel is double at the anterior end, from the posterior edge of the gizzard forward" (p. 5). Anterior to 10/11 the ventral blood vessel is often very slender, while the ventrolaterals (lateral esophageals) are large, distended with blood. These larger vessels have almost certainly been mistaken for bifurcations of the ventral trunk. (2) "A small species of *Lumbricus* also occurs in China and furnishes some interesting comparisons with the *Perichaeta*" (p. 4). Careful search of the literature has failed to reveal any record of the occurrence of *Lumbricus* in China. Presumably the generic name *Lumbricus* has been used as a convenient designation for any sort of a lumbricid worm. It is very unfortunate that Prof. Frank Smith's (1924) remarks on textbook earthworms versus real earthworms and Stephenson's comments on "the earthworm" and "the common earthworm" (1930, pp. x–xi) were not published where they would have commanded wider attention from zoologists.

PHERETIMA species, 4

1930. *Pheretima obscuritopora* CHEN, Sci. Rep. Nat. Centr. Univ. Nanking, ser. B, vol. 1, p. 28.

P. obscuritopora was erected by Chen for immature specimens on which no trace of clitellar glandularity was visible. So far as can be determined from the description, the types are not sufficiently developed to enable recognition of the specific characteristics. The spermathecae (see Chen's fig. 10, p. 36) certainly do not appear to have attained their definitive conformations. The condition figured is more or less closely approximated by very rudimentary spermathecae of aclitellate specimens of *P. tschiliensis*. The "very small crescent shaped groove" can be interpreted as an early rudiment of the type of male pore invagination that characterizes *P. tschiliensis*. The types of *P. obscuritopora* were collected from the same localities as *P. kiangsuensis* (= *P. tschiliensis*) and may, quite possibly, be merely immature forms of that species.

Chen's Szechwan specimens of *P. obscuritopora* (see Chen, 1931) may or may not be conspecific with the Nanking and Soochow specimens.

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